Scilab Textbook Companion for Geotechnical Engineering by Shashi K Gulhati & Manoj Datta[1]

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Book Description

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Scilab numbering policy used in this document and the relation to the above book.

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

AP Appendix to Example(Scilab Code that is an Appednix to a particular Example of the above book)

For example, Exa 3.51 means solved example 3.51 of this book. Sec 2.3 means a scilab code whose theory is explained in Section 2.3 of the book.

Contents

List of Scilab Codes

Chapter 2

The Three Phase System

Scilab code Exa 2.1 Comment on the values of w and S

```
//Example 2_1
clc;
clear;
close;

//Given data :
d=38;// Diameter of soil sample in mm
h=76;// Height of soil sample in mm
ww=1.15;// Wet weight of soil sample in N
dw=0.5;// Dry weight of soil sample in N
G=2.7/100000;// Specific gravity of soil sample in
W=ww-dw;// void weight in N
w=(W/dw)*100;// Water content in percentage
disp(w,"Water content in percentage is");
V=86200;// Volume in mm^3
Vs=W/G;// Volume of solids on mm^3
Vv=67.7*1000;// Volume of voids in mm^3
Vw=65*1000;// Volume of water in mm^3
S=(Vw/Vv)*100;// Degree of saturation in percentage
disp(S,"Degree of saturation in percentage is");
// The answers vary due to round off error
```

Scilab code Exa 2.2 Determination of void ratio and porosity

```
//Example 2_2
clc;
clear;
close;

//Given data :
Vv=67.7*1000;// Volume of voids in mm^3
Vs=18.5*1000;// Volume of solids in mm63
e=Vv/Vs;// Void ratio (no unit)
disp(e,"Void ratio is");
n=e/(1+e);// Porosity
disp(n,"Porosity is");
// The answers vary due to round off error
```

Scilab code Exa 2.3 Determination of total unit weight and dry weight of soil samp

```
//Example 2_3
clc;
clear;
close;

//Given data :
W=1.15/1000;// Wet weight in kN
V=86.2/1000000;// Volume in m^3
gammat=W/V;// Total unit weight in kN/m^3
disp(gammat,"Total unit weight in kN/m^3 is");
Ws=0.5/1000;// Dry weight in kN
gammad=Ws/V;// Dry unit weight in kN/m^3
disp(gammad,"Dry unit weight in kN/m^3 is");
// The answers vary due to round off error
```

Chapter 4

Effective Stress Under Hydrostatic Conditions

Scilab code Exa 4.1 Determination of magnitudes of sigma u and sigmadash at crucia

```
//Example 4_1
clc;
clear;
close;

//Given data :
uw=19;// Unit weight of sand in kN/m^3

// At elevation −10 m
disp("At Elevation −10 m:");
E=10;// Elevation in m
pi=uw*E;// Magnitude of pi in kN/m^2
u=0;// Magnitude of u in kN/m^2
pidash=pi-u;// Magnitude of pi' in kN/m^2
disp(pi,"    Magnitude of pi in kN/m^2");
disp(u,"    Magnitude of u in kN/m^2");
disp(pidash,"    Magnitude of pidash in kN/m^2");

// At elevation −25 m
```

```
disp("At Elevation -25 m:");
E=25;// Elevation in m
pi=uw*E;// Magnitude of pi in kN/m^2
u=10*15;// Magnitude of u in kN/m^2
pidash=pi-u;// Magnitude of pi' in kN/m^2
disp(pi,"    Magnitude of pi in kN/m^2");
disp(u,"    Magnitude of u in kN/m^2");
disp(pidash,"    Magnitude of pidash in kN/m^2");
```

Scilab code Exa 4.2 Determination of magnitudes of sigma u and sigmadash at crucia

```
//Example 4_2
clc;
clear;
close;

//Given data :
uw=19;// Unit weight of sand in kN/m^3

// At elevation -10 m
disp("At Elevation -10 m:");
E=10;// Elevation in m
pi=uw*E;// Magnitude of pi in kN/m^2
u=10*10;// Magnitude of u in kN/m^2
pidash=pi-u;// Magnitude of pi' in kN/m^2
disp(pi,"    Magnitude of pi in kN/m^2");
disp(u,"    Magnitude of u in kN/m^2");
disp(pidash,"    Magnitude of pidash in kN/m^2");

// At elevation -25 m
disp("At Elevation -25 m:");
E=25;// Elevation in m
pi=uw*E;// Magnitude of pi in kN/m^2
u=10*25;// Magnitude of u in kN/m^2
pidash=pi-u;// Magnitude of pi' in kN/m^2
```

```
disp(pi,"    Magnitude of pi in kN/m^2");
disp(u,"    Magnitude of u in kN/m^2");
disp(pidash,"    Magnitude of pidash in kN/m^2");
```

Scilab code Exa 4.3 Determination of magnitudes of sigma u and sigmadash at crucia

```
//Example 4_3
clc;
clear;
close;

//Given data :
uw=19;// Unit weight of sand in kN/m^3
uw1=10;// Unit weight of fill material in kN/m^3

// At elevation 0 m
disp("At Elevation 0 m:");
E=10;// Elevation in m
pi=uw1*E;// Magnitude of pi in kN/m^2
u=10*10;// Magnitude of u in kN/m^2
pidash=pi-u;// Magnitude of pi' in kN/m^2
disp(pi,"    Magnitude of pi in kN/m^2");
disp(u,"    Magnitude of u in kN/m^2");
disp(pidash,"    Magnitude of pidash in kN/m^2");

// At elevation -10 m
disp("At Elevation -10 m:");
E=10;// Elevation in m
pi1=pi+(uw*E);// Magnitude of pi in kN/m^2
u=10*20;// Magnitude of u in kN/m^2
pidash=pi1-u;// Magnitude of pi' in kN/m^2
disp(pi1,"    Magnitude of pi in kN/m^2");
disp(u,"    Magnitude of u in kN/m^2");
disp(pidash,"    Magnitude of pidash in kN/m^2");
```

```
// At elevation -25 m
disp("At Elevation -25 m:");
E=25;// Elevation in m
pi2=pi+(uw*E);// Magnitude of pi in kN/m^2
u=10*35;// Magnitude of u in kN/m^2
pidash=pi2-u;// Magnitude of pi' in kN/m^2
disp(pi2,"   Magnitude of pi in kN/m^2");
disp(u,"    Magnitude of u in kN/m^2");
disp(pidash,"   Magnitude of pidash in kN/m^2");
```

Scilab code Exa 4.4 Determination of magnitudes of sigma u and sigmadash at crucia

```
//Example 4_4
clc;
clear;
close;

//Given data :
uw=19;// Unit weight of sand in kN/m^3
uw1=20;// Unit weight of fill material in kN/m^3
// At elevation 0 m
disp("At Elevation 0 m:");
E=10;// Elevation in m
pi=uw1*E;// Magnitude of pi in kN/m^2
u=0;// Magnitude of u in kN/m^2
pidash=pi-u;// Magnitude of pi' in kN/m^2
disp(pi,"   Magnitude of pi in kN/m^2");
disp(u,"    Magnitude of u in kN/m^2");
disp(pidash,"   Magnitude of pidash in kN/m^2");

// At elevation -10 m
disp("At Elevation -10 m:");
E=10;// Elevation in m
pi1=pi+(uw*E);// Magnitude of pi in kN/m^2
u=0;// Magnitude of u in kN/m^2
```

```
pidash=pi1-u;// Magnitude of pi' in kN/m^2
disp(pi1," Magnitude of pi in kN/m^2");
disp(u," Magnitude of u in kN/m^2");
disp(pidash," Magnitude of pidash in kN/m^2");

// At elevation -25 m
disp("At Elevation -25 m:");
E=25;// Elevation in m
pi2=pi+(uw*E);// Magnitude of pi in kN/m^2
u=10*15;// Magnitude of u in kN/m^2
pidash=pi2-u;// Magnitude of pi' in kN/m^2
disp(pi2," Magnitude of pi in kN/m^2");
disp(u," Magnitude of u in kN/m^2");
disp(pidash," Magnitude of pidash in kN/m^2");
```

Chapter 6

Measuring Permeability

Scilab code Exa 6.1 Determination of the permeability of silty sand sample in the

```
//Example 6_1
clc;
clear;
close;

//Given data :
H1=3500;// Height1 in mm
H2=550;// Height2 in mm
L=300;// Length in mm
A=10000;// Area in mm^2
V=1000000;// Volume of jar in mm^3
t=50;// Time taken to fill graduated jar in seconds
DH=H1-H2;// Difference in Heights(H1-H2) in mm
k=(V/(t*A))*(L/DH)*(1/1000);// Permeability of silty
    sand sample in the permeameter in m/sec
disp(k,"Permeability of silty sand sample in the
   permeameter in m/sec");
// The answers vary due to round off error
```

Scilab code Exa 6.2 `Permeability of soil`

```
//Example 6_2
clc;
clear;
close;

//Given data :
L=150;// Length of sample in mm
D=100;// Diameter of sample in mm
d=2;// Diameter of vertical pipe in mm
a=3.14*d*d/4;// Area of the vertical pipe in mm^2
A=3.14*D*D/4;// Area of sample in mm^2
hi=350;// Height1 in mm
hf=200;// height2 in mm
t=60;// Time in seconds
V=1000000;// Volume of jar in mm^3
k=(L*a/A)*(log(hi/hf)/t)*(1/1000);// Permeability of
    silty sand sample in the permeameter in m/sec
disp(k,"Permeability of silty sand sample in the
    permeameter in m/sec");
// The answers vary due to round off error
```

Chapter 7

Effective Stress Under Steady State One Dimensional Flow

Scilab code Exa 7.1 `Distribution with depth`

```
//Example 7_1
clc;
clear;
close;

//Given data :

// At Point A
disp("At Point A");
uwa=10;// Unit weight in kN/m^3
ha=100/1000;// Height from top till point A in m
pi=uwa*ha;// Magnitude of pi in kN/m^2
u=uwa*ha;// Magnitude of u in kN/m^2
pidash=pi-u;// Magnitude of pidash in kN/m^2
disp(pi,"   Magnitude of pi in kN/m^2");
disp(u,"   Magnitude of u in kN/m^2");
disp(pidash,"   Magnitude of pidash in kN/m^2");

// At Point B
```

```
disp("At Point B");
uwb=20;// Unit weight of soil sample in kN/m^3
hb=300/1000;// Height from top till point B in m
pi=pi+(uwb*hb);// Magnitude of pi in kN/m^2
u=uwa*ha;// Magnitude of u in kN/m^2
pidash=pi-u;// Magnitude of pidash in kN/m^2
disp(pi,"   Magnitude of pi in kN/m^2");
disp(u,"   Magnitude of u in kN/m^2");
disp(pidash,"   Magnitude of pidash in kN/m^2");
```

Scilab code Exa 7.2 Distribution with depth and total head causing flow

```
//Example 7_2
clc;
clear;
close;

//Given data :

// At Point A
disp("a)");
disp("  At Point A");
uwa=10;// Unit weight in kN/m^3
ha=100/1000;// Height from top till point A in m
pi=uwa*ha;// Magnitude of pi in kN/m^2
u=uwa*ha;// Magnitude of u in kN/m^2
pidash=pi-u;// Magnitude of pidash in kN/m^2
disp(pi,"       Magnitude of pi in kN/m^2");
disp(u,"       Magnitude of u in kN/m^2");
disp(pidash,"       Magnitude of pidash in kN/m^2");

// At Point B
disp("  At Point B");
uwb=20;// Unit weight of soil sample in kN/m^3
hb=300/1000;// Height from top till point B in m
```

```
h=600/1000;// Height in mm
pi1=pi+(uwb*hb);// Magnitude of pi in kN/m^2
u=uwa*h;// Magnitude of u in kN/m^2
pidash=pi1-u;// Magnitude of pidash in kN/m^2
disp(pi1,"        Magnitude of pi in kN/m^2");
disp(u,"        Magnitude of u in kN/m^2");
disp(pidash,"        Magnitude of pidash in kN/m^2");

disp("b)");
uwb=20;// Unit weight of soil sample in kN/m^3
hb=300/1000;// Height from top till point B in m
h=700/1000;// Height in mm
pi2=pi+(uwb*hb);// Magnitude of pi in kN/m^2
u=uwa*h;// Magnitude of u in kN/m^2
pidash=pi2-u;// Magnitude of pidash in kN/m^2
disp(pi2,"        Magnitude of pi in kN/m^2");
disp(u,"        Magnitude of u in kN/m^2");
disp(pidash,"        Magnitude of pidash in kN/m^2");
disp("Therefore effective stress is zero by
    increasing the water reservoir by another 100 mm"
    );
disp(hb*1000,"Hence, the total head causing flow in
    mm");
```

Chapter 10

Measuring Compressibility Characteristics and Computing Amount of and Time for Consolidation

Scilab code Exa 10.2 Determination of Coefficient of Consolidation of the soil

```
//Example 10_2
clc;
clear;
close;

//Given data :
T90=0.848;// Time Factor Corresponding to 90% consolidation
t90=16;// Time in years
T=24/1000;// Sample thickness in m
H=T/2;// Drainage path in m
cv=T90*H*H/t90;// Coefficient of Consolidation of the soil in m^2/min
disp(cv,"Coefficient of Consolidation of the soil in m^2/min");
```

Scilab code Exa 10.3 Determination of amount of consolidation that will occur in t

```
//Example 10_3
clc;
clear;
close;

//Given data :
tc=12;// Thickness of clay layer in m
ts=5;// Thickness of dense sand layer in m
tf=5;// Height of fill in m
gc=16;// Unit weight of clay layer in kN/m^3
gs=20;// Unit weight of dense sand layer in kN/m^3
gf=18;// Unit weight of fill in kN/m^3
D=6;// Thickness in m

// Sub-layer 1
D1=3;// Depth to middle of sub-layer 1 in m
Is1=(gs*ts)+(D*D1);// Inital sigma-dash at middle of sub-layer 1 in kN/m^2
e01=1.74;// e0 at middle of sub-layer 1 (From Fig. 10.8)
Ds1=gf*tf;// Difference between final sigma-dash and initial sigma-dash in kN/m^2
Fs1=Is1+Ds1;// Final sigma-dash at middle of sub-layer 1 in kN/m^2
av1=9/10000;// in m^/kN
mv1=av1/(1+e01);// Coefficient of volume compressibility of sub-layer 1
S1=mv1*D*Ds1;// Settlement of sub-layer 1 in m
disp(S1,"Settlement of sub-layer 1 in m");

// Sub-layer 2
D2=9;// Depth to middle of sub-layer 2 in m
```

```
Is2=(gs*ts)+(D*D2);// Inital sigma-dash at middle of sub-layer 2 in kN/m^2
e02=1.70;// e0 at middle of sub-layer 2 (From Fig. 10.8)
Ds2=gf*tf;// Difference between final sigma-dash and initial sigma-dash in kN/m^2
Fs2=Is2+Ds2;// Final sigma-dash at middle of sub-layer 2 in kN/m^2
av2=8/10000;// in m^/kN
mv2=av2/(1+e02);// Coefficient of volume compressibility of sub-layer 2
S2=mv2*D*Ds2;// Settlement of sub-layer 2 in m
disp(S2,"Settlement of sub-layer 2 in m");

TS=S1+S2;// Total settlement of sub-layers in m
disp(TS,"Total settlement of sub-layers in m");
// The answers vary due to round off error
```

Scilab code Exa 10.4 Determination of amount of consolidation that will occur in t

```
//Example 10_4
clc;
clear;
close;

//Given data :
tc=12;// Thickness of clay layer in m
ts=5;// Thickness of dense sand layer in m
tf=5;// Height of fill in m
gc=16;// Unit weight of clay layer in kN/m^3
gs=20;// Unit weight of dense sand layer in kN/m^3
gf=18;// Unit weight of fill in kN/m^3
D=6;// Thickness in m
Cc=0.3;// Compression Index

```

```
// Sub-layer 1
D1=3;// Depth to middle of sub-layer 1 in m
Is1=(gs*ts)+(D*D1);// Inital sigma-dash at middle of sub-layer 1 in kN/m^2
e01=1.74;// e0 at middle of sub-layer 1 (From Fig. 10.8)
Ds1=gf*tf;// Difference between final sigma-dash and initial sigma-dash in kN/m^2
Fs1=Is1+Ds1;// Final sigma-dash at middle of sub-layer 1 in kN/m^2
S1=(Cc*log10(Fs1/Is1)*D)/(1+e01);// // Settlement of sub-layer 1 in m
disp(S1,"Settlement of sub-layer 1 in m");

// Sub-layer 2
D2=9;// Depth to middle of sub-layer 2 in m
Is2=(gs*ts)+(D*D2);// Inital sigma-dash at middle of sub-layer 2 in kN/m^2
e02=1.70;// e0 at middle of sub-layer 2 (From Fig. 10.8)
Ds2=gf*tf;// Difference between final sigma-dash and initial sigma-dash in kN/m^2
Fs2=Is2+Ds2;// Final sigma-dash at middle of sub-layer 2 in kN/m^2
S2=(Cc*log10(Fs2/Is2)*D)/(1+e02);// // Settlement of sub-layer 2 in m
disp(S2,"Settlement of sub-layer 2 in m");

TS=S1+S2;// Total settlement of sub-layers in m
disp(TS,"Total settlement of sub-layers in m");
// The answers vary due to round off error
```

Scilab code Exa 10.5 `Time period`

```
//Example 10_5
```

```
clc;
clear;
close;

//Given data :
C=2/1000000;// Coefficient of Consolidation in m^2/
    min
ts=1;// Thickness of sand layer in m
H=6;// Thicknes of clay layer in m
T50=0.197;// Time Factor Corresponding to 50%
    consolidation
T90=0.848;// Time Factor Corresponding to 90%
    consolidation
t50=T50*H*H/(C*60*24*30*12);// Time taken for 50%
    consolidation to take place in years
t90=T90*H*H/(C*60*24*30*12);// Time taken for 90%
    consolidation to take place in years
disp(t50,"Time taken for 50% consolidation to take
    place in years");
disp(t90,"Time taken for 90% consolidation to take
    place in years");
// The answers vary due to round off error
```

Chapter 12

Shear Strength Parameters

Scilab code Exa 12.1 Percentage error

```
//Example 12_1
clc;
clear;
close;

//Given data :
// With reference to Fig 12.14
a=100;// (pi1 - pi3)f/2 in kN/m^2
angle=30;// angle in degree
towff=150*tand(angle);// towff in kN/m^2
err=(a-towff)/towff*100;// Error in percentage
disp(err,"Error in percentage");
// The answers vary due to round off error
```

Scilab code Exa 12.2 Determination of Su and Sd

```
//Example 12_2
clc;
```

```
clear;
close;

//Given data :
// With reference to Fig 12.15
ecs=100;// Effective Confining Stress in kN/m^2
Af=1;// Assumption
angle=30;// Angle in degree
Sd=ecs*(sind(angle)/(1-sind(angle)));// Shear
    strength under drained condition in kN/m^2
Su=ecs*(sind(angle)/(1-(1-(2*Af))*sind(angle)));//
    Shear strength under undrained condition in kN/m
    ^2
disp(Sd,"Shear strength under drained condition in
    kN/m^2");
disp(Su,"Shear strength under undrained condition in
    kN/m^2");
// The answers vary due to round off error
```

Scilab code Exa 12.3 Determination of Su and Sd

```
//Example 12_3
clc;
clear;
close;

//Given data :
// With reference to Fig 12.16
ecs=100;// Effective Confining Stress in kN/m^2
Af=-0.5;// Assumption
cdash=50;// cdash in kN/m^2
angle=25;// Angle in degree
Sd=(ecs+(cdash*cotd(angle)))*(sind(angle)/(1-sind(
    angle)));// Shear strength under drained
    condition in kN/m^2
```

```
Su=(ecs+(cdash*cotd(angle)))*(sind(angle)/(1-(1-(2*
    Af))*sind(angle)));// Shear strength under
    undrained condition in kN/m^2
disp(Sd,"Shear strength under drained condition in
    kN/m^2");
disp(Su,"Shear strength under undrained condition in
     kN/m^2");
// The answers vary due to round off error
// The answer provided in the textbook is wrong
```

Chapter 17

Site Investigation

Scilab code Exa 17.1 N value

```
//Example 17_1
clc;
clear;
close;

//Given data :
disp("a)");
uw=20;// Unit weight of sand in kN/m^3
d=2;// Depth in m
pi=uw*d;// Magnitude of pi at 2 m depth in kN/m^2
u=10*(d-1);// Magnitude of u at 2 m depth in kN/m^2
pidash=pi-u;// magnitude of pidash at 2 m depth in
    kN/m2
CN=1.4;// Value of CN from Fig 17.14
N=5;// Observed value of N
Ndash=CN*N;// value of Ndash
// 7<15 therefore no dilatency correction needs to
    be applied
Ndashdash=Ndash;// Correct value of N
disp(Ndashdash,"Correct value of N is");
```

```
disp("b)");
uw=20;// Unit weight of sand in kN/m^3
d=15;// Depth in m
pi=uw*d;// Magnitude of pi at 15 m depth in kN/m^2
u=10*(d-1);// Magnitude of u at 15 m depth in kN/m^2
pidash=pi-u;// magnitude of pidash at 15 m depth in kN/m2
CN=0.82;// Value of CN from Fig 17.14
N=21;// Observed value of N
Ndash=CN*N;// value of Ndash
// 17>15 therefore dilatency correction needs to be applied
Ndashdash=15+((Ndash-15)/2);// Correct value of N
disp(Ndashdash,"Correct value of N is");
// The answers vary due to round off error
```

Chapter 18

Flow Analysis

Scilab code Exa 18.1 Quantity of water flowing into lake

```
//Example 18_1
clc;
clear;
close;

//Given data :
k=1/100000000;// Permeability in m/sec
L=10;// Thickness of clay layer in m
A=1;// Lake bed area in m^2
DH=10;// Difference in height in m
Q=k*(DH/L)*A*60*60;// Discharge in m^3/hr
disp(Q,"Discharge in m^3/hr");
// The answers vary due to round off error
```

Scilab code Exa 18.2 Determination of quantity of water flow through each of the t

```
//Example 18_2
clc;
```

```
clear;
close;

//Given data :
// Clay
k=1/1000000000;// Permeability in m/sec
L=0.5;// Thickness of clay layer in m
A=100;// Lake bed area in mm^2
DH=1;// Difference in height in m
Q1=k*(DH/L)*A*1000*60*60;// Discharge in clay in mm
    ^3
disp(Q1,"Discharge in clay in mm^3");

// Silt
k=1/1000000;// Permeability in m/sec
L=0.5;// Thickness of clay layer in m
A=100;// Lake bed area in mm^2
DH=1;// Difference in height in m
Q2=k*(DH/L)*A*1000*60*60;// Discharge in silt in mm
    ^3
disp(Q2,"Discharge in silt in mm^3");

// Sand
k=1/10000;// Permeability in m/sec
L=0.5;// Thickness of clay layer in m
A=100;// Lake bed area in mm^2
DH=1;// Difference in height in m
Q3=k*(DH/L)*A*1000*60*60;// Discharge in sand in mm
    ^3
disp(Q3,"Discharge in sand in mm^3");
TF=Q1+Q2+Q3;// Total flow in mm^3
disp(TF,"Total flow in mm^3");
```

Scilab code Exa 18.4 `Gradient along the flow line`

```
//Example 18_4
clc;
clear;
close;

//Given data :
k=1/100000;// Permeability in m/sec
nf=3;//
nd=10.5;//
H1=5.5;// Height 1 in m
H2=0.25;// Height 2 in m
DH=H1-H2;// Difference in height in m
Q=k*DH*(nf/nd);// Discharge in mm^3/sec
disp(Q,"Discharge in mm^3/sec");
Lgh=0.55;// Length in m
EG=(DH/(nd*Lgh));// Exit gradient along GH
disp(EG,"Exit gradient along GH is");
// The answers vary due to round off error
```

Scilab code Exa 18.5 Quantity of water flowing

```
//Example 18_5
clc;
clear;
close;

//Given data :
k=1/10000000;// Permeability in m/sec
nf=3;//
nd=12;//
H1=26;// Height 1 in m
H2=2;// Height 2 in m
DH=H1-H2;// Difference in height in m
Q=k*DH*(nf/nd);// Discharge in mm^3/sec
disp(Q,"Discharge in mm^3/sec");
```

```
EG=1.5;// Exit gradient at the filter drain
disp("The exit gradient is more than 1.0. But this is no cause for concern because the direction of flow is downward");
// The answers vary due to round off error
```

Scilab code Exa 18.6 Determination of discharge of water

```
//Example 18_6
clc;
clear;
close;

//Given data :
Ta=12;// Thickeness of aquifier in m
Tg=2;// Thickness of ground water table in m
H=Ta-Tg;// Height between aquifier and ground water table in m
R=200;// Radius of influence in m
hA=5;// Height at point A in m
k=2/100000;// Permeability of soil in m/sec
// 1 m below excavation level at 6 m below ground surface)
xL=8;// Distance from point A to each well in m
xM=8;// Distance from point A to each well in m
xN=8;// Distance from point A to each well in m
xO=8;// Distance from point A to each well in m
N=4;// Total number of wells
Q=(((H^2)-(hA^2))*3.14*k)/(4*log(R/xL));// Discharge of water from each well in m^3/s
disp(Q,"Discharge of water from each well in m^3/s");
// The answers vary due to round off error
```

Scilab code Exa 18.7 Level of water in each well

```
//Example 18_7
clc;
clear;
close;

//Given data :
Q=36.6/100000;// Discharge in m^3/sec
Ta=12;// Thickeness of aquifier in m
Tg=2;// Thickness of ground water table in m
H=Ta-Tg;// Height between aquifier and ground water table in m
R=200;// Radius of influence in m
rw=0.150/2;// Radius of each well in m
k=2/100000;// Permeability of soil in m/sec
// 1 m below excavation level at 6 m below ground surface)
xM=10;// Distance from well L to well M in m
xN=16;// Distance from well L to well N in m
xO=10;// Distance from well L to well O in m
hw=sqrt((H^2)-((Q/(3.14*k))*(log(R/rw)+log(R/xM)+log(R/xN)+log(R/xO))));// Water level in each well in m
disp(hw,"Water level in each well in m");
// The answers vary due to round off error
```

Chapter 19

Settlement Analysis

Scilab code Exa 19.3 Estimation of settlement

```
//Example 19_3
clc;
clear;
close;

//Given data :
// The clay is overconsolidated
// Assume lambda from Table 19.3

// assumption 1
lambda=0.5;
cs=100*lambda;// Corrected settlement for 0.5 lambda
    value in mm
disp(cs,"Corrected settlement for 0.5 lambda value
   in mm");

// assumption 2
lambda=0.6;
cs=100*lambda;// Corrected settlement for 0.6 lambda
    value in mm
disp(cs,"Corrected settlement for 0.6 lambda value
```

```
in mm");
```

Scilab code Exa 19.4 Computation of elastic settlement of the footing

```
//Example 19_4
clc;
clear;
close;

//Given data :
E=5;// Undrained modulus of clay in N/mm^2
mu=0.5;
B=2;
q=150;
ce=1.36;// L/B = 1.5 at centre is 1.36
co=0.68;// L/B = 1.5 at centre is 0.68
rhoece=q*B*(1-(mu^2))*(ce/E);// Elastic settlement at centre in mm
disp(rhoece,"Elastic settlement at centre in mm");
rhoeco=q*B*(1-(mu^2))*(co/E);// Elastic settlement at corner in mm
disp(rhoeco,"Elastic settlement at corner in mm");
AVG=(rhoece+rhoeco)/2;// Average elastic settlement in mm
disp(AVG,"Average elastic settlement in mm");
// Consolidated settlement range is 566 mm to 629 mm
CS=600;// Consolidated settlement in mm
P=(AVG)*100/CS;
disp(P,"Elastic settlement is less than consolidated settlement in % by");
// The answers vary due to round off error
```

Scilab code Exa 19.5 Computation of immediate settlement beneath the center of a f

```
//Example 19_5
clc;
clear;
close;

//Given data :
Su=150;// Average undrained strength in kN/m^2
E=300*Su/1000;//Undrained modulus of soil in N/mm^2
disp("(i)");
B=5;
q=100;
mu=0.35;
ce=1.12;// L/B = 1.5 at centre is 1.12
rhoece=q*B*(1-(mu^2))*(ce/E);// Elastic settlement
    at centre in mm
disp(rhoece,"   Elastic settlement at centre in mm")
    ;
// The answers vary due to round off error

disp("(ii)");
E1=30;// Undrained modulus of sand in N/mm^2
h1=10;// Depth1 in m
E2=60;// Undrained modulus of sand in N/mm^2
h2=15;// Depth2 in m
Eavg=((E1*h1)+(E2*h2))/(h1+h2)*1000;// Average
    Undrained modulus in kN/m^2
mu=.3;
rhoece=q*B*(1-(mu^2))*(ce/E);// Elastic settlement
    at centre in mm
disp(rhoece,"   Elastic settlement at centre in mm")
    ;
// The answers vary due to round off error
```

Scilab code Exa 19.6 Corrections in rigidity and depth

```
//Example 19_6
clc;
clear;
close;

//Given data :
AS=0.8*60;// Average settlement in mm
DF=0.87;// Depth Factor
CS=600*DF;// Consolidation Settlement corrected for depth in mm
disp(CS,"Consolidation Settlement corrected for depth in mm");
ES=AS*DF;// Elastic Settlement corrected for both rigidity and depth in mm
disp(ES,"Elastic Settlement corrected for both rigidity and depth in mm");
// The answers vary due to round off error
```

Scilab code Exa 19.7 Estimate of settlement and error in it

```
//Example 19_7
clc;
clear;
close;

//Given data :
E=60;//Undrained modulus of soil in N/mm^2
disp("(a)");
B=20;
q=150;
mu=0.3;
I=0.38;// Influence factor
rhoece=q*B*(1-(mu^2))*(I/E);// Elastic settlement at centre in mm
disp(rhoece," Elastic settlement at centre in mm");
```

```
RF=0.8;// Rigidity Factor
a=1;
crhoece=rhoece*RF*a;// Corrected Elastic settlement
   at centre in mm
disp(crhoece," Corrected Elastic settlement at
   centre in mm");
// The answers vary due to round off error

disp("(b)");
I=1.12;// Influence factor
rhoece=q*B*(1-(mu^2))*(I/E);// Elastic settlement at
    centre in mm
disp(rhoece,"  Elastic settlement at centre in mm")
   ;
RF=0.8;// Rigidity Factor
a=1;
crhoece=rhoece*RF*a;// Corrected Elastic settlement
   at centre in mm
disp(crhoece," Corrected Elastic settlement at
   centre in mm");
// The answer provided in the textbook is wrong
```

Chapter 20

Bearing Capacity Analysis

Scilab code Exa 20.1 `Calculation of ultimate bearing capacity for a footing in san`

```
//Example 20_1
clc;
clear;
close;

//Given data :
disp("a)- Very deep water table");
B=2;// Width of foundation in m
Df=1;// Depth of foundation in m
gammat=18;// Unit weight of soil in kN/m^2
teta=35;// Angle in degree
Nq=41;// Bearing capacity factor
Ng=42;// Bearing capacity factor
qult=(Df*gammat*Nq)+(0.5*gammat*B*Ng);// Ultimate bearing capacity for footing in sand in kN/m^2
disp(qult,"      Ultimate bearing capacity for footing in sand in kN/m^2");

disp("b)- Very deep water table");
B=2;// Width of foundation in m
Df=2;// Depth of foundation in m
```

```
gammat=18;// Unit weight of soil in kN/m^2
teta=35;// Angle in degree
Nq=41;// Bearing capacity factor
Ng=42;// Bearing capacity factor
qult=(Df*gammat*Nq)+(0.5*gammat*B*Ng);// Ultimate
    bearing capacity for footing in sand in kN/m^2
disp(qult,"      Ultimate bearing capacity for
    footing in sand in kN/m^2");

disp("c)- Very deep water table");
B=4;// Width of foundation in m
Df=1;// Depth of foundation in m
gammat=18;// Unit weight of soil in kN/m^2
teta=35;// Angle in degree
Nq=41;// Bearing capacity factor
Ng=42;// Bearing capacity factor
qult=(Df*gammat*Nq)+(0.5*gammat*B*Ng);// Ultimate
    bearing capacity for footing in sand in kN/m^2
disp(qult,"      Ultimate bearing capacity for
    footing in sand in kN/m^2");

disp("d)- Ground surface water table");
B=2;// Width of foundation in m
Df=1;// Depth of foundation in m
gammat=18;// Unit weight of soil in kN/m^2
teta=35;// Angle in degree
Nq=41;// Bearing capacity factor
Ng=42;// Bearing capacity factor
qult=(Df*gammat*Nq)+(0.5*gammat*B*Ng);// Ultimate
    bearing capacity for footing in sand in kN/m^2
disp(qult,"      Ultimate bearing capacity for
    footing in sand in kN/m^2");
// The answer provided in the textbook is wrong

disp("e)- Very deep water table");
B=2;// Width of foundation in m
Df=1;// Depth of foundation in m
gammat=20;// Unit weight of soil in kN/m^2
```

```
teta=37.5;// Angle in degree
Nq=61;// Bearing capacity factor
Ng=86;// Bearing capacity factor
qult=(Df*gammat*Nq)+(0.5*gammat*B*Ng);// Ultimate
   bearing capacity for footing in sand in kN/m^2
disp(qult,"     Ultimate bearing capacity for
   footing in sand in kN/m^2");
```

Scilab code Exa 20.3 Altered dimensions of the footing

```
//Example 20_3
clc;
clear;
close;

//Given data :
a=2;// Side of footing in m
UL=600;// Ultimate vertical load of footing in kN
M1=90;// Ultimate moment of footing in one direction
    in kNm
M2=60;// Ultimate moment of footing in other
   direction in kNm
e1=M1/UL;// Eccentricity in the direction 90kNM acts
    in m
L=a+(a*e1);// Dimension of footing increased in the
   direction of 90kNm moment in m
disp(L,"Dimension of footing increased in the
   direction of 90kNm moment in m");
e2=M2/UL;// Eccentricity in the direction 90kNM acts
    in m
L=a+(a*e2);// Dimension of footing increased in the
   direction of 60kNm moment in m
disp(L,"Dimension of footing increased in the
   direction of 60kNm moment in m");
```

Scilab code Exa 20.4 Determination of Major principle stress at failure

```
//Example 20_4
clc;
clear;
close;

//Given data :
B=2;// Width of foundation in m
Df=1.5;// Depth of foundation in m
Rw=1;
Rwdash=1;
Ndashdash=14;
qult=(1/62)*((2*Ndashdash*Ndashdash*B*Rwdash)
    +(6*(100+(Ndashdash^2))*Df*Rw));// Ultimate
    bearing capacity  in kN/m^2
disp(qult,"Ultimate bearing capacity  in kN/m^2");
// The answers vary due to round off error
```

Scilab code Exa 20.5 Computations of Unit End Bearing and Unit Skin Friction

```
//Example 20_5
clc;
clear;
close;

//Given data :
gt1=20;// Unit weight of top layer in kN/m^3
t1=12;// Thickness of top layer in m
teta1=30;// Angle of top layer in degree
gt2=22;// Unit weight of bottom layer in kN/m^3
t2=20;// Thickness of bottom layer in m
```

```
teta2=35;// Angle of bottom layer in degree
K=1;// Coefficient of earth pressure
Nq1=20;
Nq2=50;

disp("For depth 10 m");
svdash=(gt1-10)*10;// Vertical effective stress in kN/m2
a=tand(teta1);
qb=svdash*Nq1;// Unit End Bearing in kN/m^2
disp(qb,"   Unit End Bearing in kN/m^2");
fs=K*svdash*a;// Unit Skin Friction in kN/m^2
disp(fs,"   Unit Skin Friction in kN/m^2");
// The answers vary due to round off error

disp("For depth 15 m");
svdash=((gt1-10)*t1)+((gt2-10)*(15-t1));// Vertical effective stress in kN/m2
a=tand(teta2);
qb=svdash*Nq2;// Unit End Bearing in kN/m^2
disp(qb,"   Unit End Bearing in kN/m^2");
fs=K*svdash*a;// Unit Skin Friction in kN/m^2
// This value is more than the limiting value which is 100 kN/m^2, hence fs=100 kN/m^2
fs=100;// Unit Skin Friction in kN/m^2
disp(fs,"   Unit Skin Friction in kN/m^2");

disp("For depth 20 m");
svdash=((gt1-10)*t1)+((gt2-10)*(20-t1));// Vertical effective stress in kN/m2
a=tand(teta2);
qb=svdash*Nq2;// Unit End Bearing in kN/m^2
// This value is more than the limiting value which is 10000 kN/m^2, hence qb=10000 kN/m^2
qb=10000;// Unit End Bearing in kN/m^2
disp(qb,"   Unit End Bearing in kN/m^2");
// fs is alredy at limiting value. i.e==> fs=100 kN/m^2
```

```
fs=100;// Unit Skin Friction in kN/m^2
disp(fs,"   Unit Skin Friction in kN/m^2");

disp("For depth 25 m");
// qb and fs both are at limiting values
qb=10000;// Unit End Bearing in kN/m^2
disp(qb,"   Unit End Bearing in kN/m^2");
fs=100;// Unit Skin Friction in kN/m^2
disp(fs,"   Unit Skin Friction in kN/m^2");
```

Scilab code Exa 20.7 Determination of design load on pile

```
//Example 20_7
clc;
clear;
close;

//Given data :
D=300;// Diameter of pile in mm

disp("i)");
d=10/100*D;// 10% of pile diamater in mm
x1=27;// Settlement in mm
x2=34;// Settlement in mm
y1=140;// Load in kN
y2=160;// Load in kN
l=((d-x1)*(y2-y1)/(x2-x1))+y1;// Load at 30mm pile diamater settlement in kN
l=l/2;// Half the load at 30mm pile diamater settlement in kN
disp(l,"Half the load at 30mm pile diamater settlement in kN");
// The answers vary due to round off error

disp("ii)");
```

```
d=12;// pile diamater in mm
x1=10;// Settlement in mm
x2=13;// Settlement in mm
y1=60;// Load in kN
y2=80;// Load in kN
l=((d-x1)*(y2-y1)/(x2-x1))+y1;// Load at 30mm pile
    diamater settlement in kN
l=l*2/3;// Two-third of the load at 12mm pile
    diamater settlement in kN
disp(l,"Two-third of the load at 12mm pile diamater
    settlement in kN");
// The answers vary due to round off error
```

Chapter 21

Slope Stability Analysis

Scilab code Exa 21.1 Distance of failure plane

```
//Example 21_1
clc;
clear;
close;

//Given data :
d1=4;// Depth of layer A in m
d2=6;// Depth of layer B in m
c=30;// Average Su
gt1=19;// Unit weight of layer A in kN/m^3
gt2=20;// Unit weight of layer B in kN/m^3
Su1=30;// Undrained shear strength of layer A in kN/
    m^2
Su2=50;// Undrained shear strength of layer B in kN/
    m^2
i=20;// Slope in degree

disp("Layer A");
ZA=c/(gt1*cosd(i)*sind(i));// Depth to failure plane
     in m
disp(ZA,"    Depth to failure plane in m");
```

```
// The answers vary due to round off error

disp("layer B");
Z=4;// Depth in m
GA=gt1*Z*cosd(i)*sind(i);// Driving stress produced
   by layer A in kN/m^2
Cleft=Su2-GA;// Strength left in soil of layer B to
   resist the driving stress generated by layer B in
   kN/m^2
ZB=Cleft/(gt2*cosd(i)*sind(i));// Depth to failure
   plane in m
disp(round(ZB),"   Depth to failure plane in m");
d=d2-ZB;
disp(round(d),"Failure at layer B will occur on
   plane located above the rock surface in m");
```

Scilab code Exa 21.2 `Stability of water table`

```
//Example 21_2
clc;
clear;
close;

//Given data :
gt=19;// Unit weight of sand in kN/m^3
teta=30;// slope in degree
gw=10;// Unit weight of water in kN/m^3
i=atand(tand(teta)*((gt-gw)/gt));// Slope in degree
disp(i,"The slope will be stable in degree");
// The answers vary due to round off error
```

Scilab code Exa 21.3 `Determination of Safety Factor`

```
//Example 21_3
clc;
clear;
close;

//Given data :
Su=40;// Undrained shear strength of clay in kN/m^2
gt=20;// Unit weight of clay in kN/m^3
betaa=30;// Inclined angle in degree
H=10;// Elevation difference in m
D=2;
Ns=0.172;// Stability number (From table 21.1)
Cr=gt*H*Ns;// Amount of c required to maintain
    stable slope kN/m^2
C=40;// Cohesion intercept in kN/m^2
SF=C/Cr;// Safety Factor of a finite slope in clay
disp(SF,"Safety Factor of a finite slope in clay");
// The answers vary due to round off error
```

Scilab code Exa 21.4 Determination of Safety Factor

```
//Example 21_4
clc;
clear;
close;

//Given data :
teta=30;// Slope in degree
c=0;// Cohesion intercept in kN/m^2
T1=-2;// Wsin(alpha) of slice no. 1
T2=-1;// Wsin(alpha) of slice no. 1
T3=0;// Wsin(alpha) of slice no. 1
T4=2;// Wsin(alpha) of slice no. 1
T5=3;// Wsin(alpha) of slice no. 1
T6=4;// Wsin(alpha) of slice no. 1
```

```
T7=3;// Wsin(alpha) of slice no. 1
T=T1+T2+T3+T4+T5+T6+T7;// Total Wsin(alpha) of slice no. 1 to 7
P1=2;// Wsin(alpha) of slice no. 1
P2=3;// Wsin(alpha) of slice no. 1
P3=5;// Wsin(alpha) of slice no. 1
P4=4;// Wsin(alpha) of slice no. 1
P5=5;// Wsin(alpha) of slice no. 1
P6=2;// Wsin(alpha) of slice no. 1
P7=1;// Wsin(alpha) of slice no. 1
P=P1+P2+P3+P4+P5+P6+P7;// Total Wsin(alpha) of slice no. 1 to 7
SF=(P*tand(teta))/T;// Safety Factor of the slope
disp(SF,"Safety Factor of the slope");
// The answers vary due to round off error
```

Chapter 22

Earth Pressure Analysis

Scilab code Exa 22.1 Determination of active earth pressure and total lateral pres

```
//Example 22_1
clc;
clear;
close;

//Given data :
H=6;// Vertical height of wall in m

disp("(a)");
teta1=30;// Slope in degree
c=0;// Cohesion intercept in kN/m^2
g=18;// Unit weight of sand in kN/m^3
Ka=(1-sind(teta1))/(1+sind(teta1));// Coefficient of Active Earth Pressure
// At top of the wall
sigmav1=0;// Vertical stress in kN/m^2
sigmah1=Ka*sigmav1;// Horizontal stress in kN/m^2
// At base of the wall
sigmav2=g*H;// Vertical stress in kN/m^2
sigmah2=Ka*sigmav2;// Horizontal stress in kN/m^2
printf("    The active pressure increases linearly
```

```
from %d to %d kN/m^2\n",sigmah1,sigmah2);
Pa=0.5*Ka*g*H*H;// Total lateral pressure per metre run of the wall in kN/m
disp(Pa,"    Total lateral pressure per metre run of the wall in kN/m");

disp("(b)");
teta2=40;// Slope in degree
c=0;// Cohesion intercept in kN/m^2
g=20;// Unit weight of sand in kN/m^3
Ka=(1-sind(teta2))/(1+sind(teta2));// Coefficient of Active Earth Pressure
// At top of the wall
sigmav1=0;// Vertical stress in kN/m^2
sigmah1=Ka*sigmav1;// Horizontal stress in kN/m^2
// At base of the wall
sigmav2=g*H;// Vertical stress in kN/m^2
sigmah2=Ka*sigmav2;// Horizontal stress in kN/m^2
printf("    The active pressure increases linearly from %d to %0.2f kN/m^2\n",sigmah1,sigmah2);
Pa=0.5*Ka*g*H*H;// Total lateral pressure per metre run of the wall in kN/m
disp(Pa,"    Total lateral pressure per metre run of the wall in kN/m");
// The answers vary due to round off error
```

Scilab code Exa 22.2 Determination of active earth pressure and total active force

```
//Example 22_2
clc;
clear;
close;

//Given data :
teta1=30;// Slope in degree
```

```
c=0;// Cohesion intercept in kN/m^2
g1=18;// Unit weight of sand in kN/m^3
g2=21;// Unit weight of sand in kN/m^3
gw=10;// Unit weight of water in kN/m^3
Ka=(1-sind(teta1))/(1+sind(teta1));// Coefficient of Active Earth Pressure
// At top of wall
H1=0; // Depth in m
sigmav1=g1*H1;// Vertical stress in kN/m^2
sigmah1=Ka*sigmav1;// Horizontal stress in kN/m^2
disp(sigmah1,"Active pressure at top of wall in kN/m^2");
// At 2 m below top of wall
H2=2;// Depth in m
sigmav2=g1*H2;// Vertical stress in kN/m^2
sigmah2=Ka*sigmav2;// Horizontal stress in kN/m^2
disp(sigmah2,"Active pressure at 2 m below top of wall in kN/m^2");
// At 6 m below top of wall
H3=6;// Depth in m
sigmav3=sigmav2+(g2*(H3-H2))-(gw*(H3-H2));// Vertical stress in kN/m^2
sigmah3=Ka*sigmav3;// Horizontal stress in kN/m^2
disp(sigmah3,"Active pressure at 6 m below top of wall in kN/m^2");
Pa1=0.5*H2*sigmah2;// Lateral pressure per metre run of the wall in kN/m
disp(Pa1,"  Lateral pressure Pa1 per metre run of the wall in kN/m");
Pa2=0.5*(H2+H3)*sigmah2;// Lateral pressure per metre run of the wall in kN/m
disp(Pa2,"  Lateral pressure Pa2 per metre run of the wall in kN/m");
Pa3=0.5*(H3-H2)*(sigmah3-sigmah2);// Lateral pressure per metre run of the wall in kN/m
disp(Pa3,"  Lateral pressure Pa3 per metre run of the wall in kN/m");
// The answers vary due to round off error
```

```
Pw=0.5*(H3-H2)*(gw*(H3-H2));// Lateral pressure per metre run of the wall in kN/m
disp(Pw,"  Lateral pressure Pw per metre run of the wall in kN/m");
TP=Pa1+Pa2+Pa3+Pw;// Total lateral pressure per metre run of the wall in kN/m
disp(TP,"  Total lateral pressure per metre run of the wall in kN/m");
// The answers vary due to round off error
z=(((4+(2/3))*Pa1)+(2*Pa2)+(4/3*Pa3)+(4/3*Pw))/TP;// Point of application of Total lateral pressure in m
disp(z,"Point of application of Total lateral pressure in m");
// The answers vary due to round off error
```

Scilab code Exa 22.3 Determination of total active force acting on the wall

```
//Example 22_3
clc;
clear;
close;

//Given data :
H=6;// Vertical height of wall in m
teta1=30;// Slope in degree
gt=18;// Unit weight of sand in kN/m^3
disp("(i)");
a=90;// Alpha in degree
b=0;// Beta in degree
g=0;// Gamma in degree
Ka=((sind(a-teta1)/sind(a))/(sqrt(sind(a+g))+sqrt(sind(teta1+g)*sind(teta1-b)/sind(a-b))))^2;// Coefficient of Active Earth Pressure
disp(Ka,"   Coefficient of Active Earth Pressure");
```

```
Pa=0.5*Ka*gt*H*H;// Total lateral pressure per metre
    run of the wall in kN/m
disp(Pa,"   Total lateral pressure per metre run of
   the wall in kN/m");

disp("(ii)");
a=90;// Alpha in degree
b=15;// Beta in degree
g=0;// Gamma in degree
Ka=((sind(a-teta1)/sind(a))/(sqrt(sind(a+g))+sqrt(
   sind(teta1+g)*sind(teta1-b)/sind(a-b))))^2;//
   Coefficient of Active Earth Pressure
disp(Ka,"   Coefficient of Active Earth Pressure");
Pa=0.5*Ka*gt*H*H;// Total lateral pressure per metre
    run of the wall in kN/m
disp(Pa,"   Total lateral pressure per metre run of
   the wall in kN/m");
// The answers vary due to round off error
```

Scilab code Exa 22.4 Determination of total active force acting on the wall

```
//Example 22_4
clc;
clear;
close;

//Given data :
H=6;// Vertical height of wall in m
teta1=30;// Slope in degree
gt=18;// Unit weight of sand in kN/m^3
disp("(i)");
a=90;// Alpha in degree
b=0;// Beta in degree
g=0;// Gamma in degree
Ka=((sind(a-teta1)/sind(a))/(sqrt(sind(a+g))+sqrt(
```

```
sind(teta1+g)*sind(teta1-b)/sind(a-b))))^2;// Coefficient of Active Earth Pressure
disp(Ka,"    Coefficient of Active Earth Pressure");
Pa=0.5*Ka*gt*H*H;// Total lateral pressure per metre run of the wall in kN/m
disp(Pa,"    Total lateral pressure per metre run of the wall in kN/m");

disp("(ii)");
a=90;// Alpha in degree
b=0;// Beta in degree
g=20;// Gamma in degree
Ka=((sind(a-teta1)/sind(a))/(sqrt(sind(a+g))+sqrt(sind(teta1+g)*sind(teta1-b)/sind(a-b))))^2;// Coefficient of Active Earth Pressure
disp(Ka,"    Coefficient of Active Earth Pressure");
Pa=0.5*Ka*gt*H*H;// Total lateral pressure per metre run of the wall in kN/m
disp(Pa,"    Total lateral pressure per metre run of the wall in kN/m");
// The answers vary due to round off error
Pah=Pa*cosd(g);// Total horizontal lateral pressure per metre run of the wall in kN/m
disp(Pah,"Total horizontal lateral pressure per metre run of the wall in kN/m");
Pav=Pa*sind(g);// Total vertical lateral pressure per metre run of the wall in kN/m
disp(Pav,"Total vertical lateral pressure per metre run of the wall in kN/m");
// The answers vary due to round off error
```

Scilab code Exa 22.5 Determination of total active force acting on the wall

```
//Example 22_5
clc;
```

```
clear;
close;

//Given data :
H=6;// Vertical height of wall in m
teta1=30;// Slope in degree
gt=18;// Unit weight of sand in kN/m^3
disp("(i)");
a=90;// Alpha in degree
b=0;// Beta in degree
g=0;// Gamma in degree
Ka=((sind(a-teta1)/sind(a))/(sqrt(sind(a+g))+sqrt(
   sind(teta1+g)*sind(teta1-b)/sind(a-b))))^2;//
   Coefficient of Active Earth Pressure
disp(Ka,"   Coefficient of Active Earth Pressure");
Pa=0.5*Ka*gt*H*H;// Total lateral pressure per metre
    run of the wall in kN/m
disp(Pa,"   Total lateral pressure per metre run of
   the wall in kN/m");

disp("(ii)");
a=110;// Alpha in degree
b=0;// Beta in degree
g=00;// Gamma in degree
Ka=((sind(a-teta1)/sind(a))/(sqrt(sind(a+g))+sqrt(
   sind(teta1+g)*sind(teta1-b)/sind(a-b))))^2;//
   Coefficient of Active Earth Pressure
disp(Ka,"   Coefficient of Active Earth Pressure");
Pa=0.5*Ka*gt*H*H;// Total lateral pressure per metre
    run of the wall in kN/m
disp(Pa,"   Total lateral pressure per metre run of
   the wall in kN/m");
// The answers vary due to round off error
teta2=20;// Angle in degree
Pah=Pa*cosd(teta2);// Total horizontal lateral
   pressure per metre run of the wall in kN/m
disp(Pah,"Total horizontal lateral pressure per
   metre run of the wall in kN/m");
```

```
Pav=Pa*sind(teta2);// Total vertical lateral pressure per metre run of the wall in kN/m
// The answers vary due to round off error
disp(Pav,"Total vertical lateral pressure per metre run of the wall in kN/m");
// The answer provided in the textbook is wrong
```

Scilab code Exa 22.6 Determination of active earth pressure and total active force

```
//Example 22_6
clc;
clear;
close;

//Given data :
H=6;// Vertical height of wall in m
q=12;// Uniform surcharge in kN/m^2
teta1=30;// Slope in degree
g=18;// Unit weight of sand in kN/m^3
Ka=(1-sind(teta1))/(1+sind(teta1));// Coefficient of Active Earth Pressure
Pa=0.5*Ka*g*H*H;// Total lateral pressure per metre run of the wall in kN/m
disp(Pa,"Lateral pressure per metre run of the wall in kN/m");
AP=Ka*q;// Additional Active Pressure on account of surcharge acting along entire height of wall in kN/m^2
disp(AP,"Additional Active Pressure on account of surcharge acting along entire height of wall in kN/m^2");
Pa1=AP*H;// Additional lateral pressure on account of surcharge per metre run of the wall in kN/m
disp(Pa1,"Additional lateral pressure on account of surcharge per metre run of the wall in kN/m");
```

```
TP=Pa+Pa1;// Total lateral pressure per metre run of the wall in kN/m
disp(TP,"Total lateral pressure per metre run of the wall in kN/m");
z=((Pa*2)+(Pa1*3))/TP;// Point of application of Total Lateral pressure in m
disp(z,"Point of application of Total Lateral pressure in m");
// The answers vary due to round off error
```

Scilab code Exa 22.7 Determination of active pressure and total lateral pressure f

```
//Example 22_7
clc;
clear;
close;

//Given data :
disp("i)For the short term");
c=50;// in kN/m^2
teta=0;// Slope in degree
H=6;// Vertical height of wall in m
g=18;// Unit weight of soil in kN/m^3
// At top of the wall
sigmav1=0;// Vertical stress in kN/m^2
sigmaa1=sigmav1-(2*c);// Active pressure in kN/m^2
// At base of the wall
sigmav2=g*H;// Vertical stress in kN/m^2
sigmaa2=sigmav2-(2*c);// Active pressure in kN/m^2
z=2*c/g;// Point at which active earth pressure is zero in m
Pa=0.5*(H-z)*sigmaa2;// Total lateral pressure per metre run of the wall in kN/m
disp(Pa,"    Total lateral pressure per metre run of the wall in kN/m");
```

```
Z=(H-z)/3;// Point of application of Lateral pressure on the wall above the base in m
disp(Z,"     Point of application of Lateral pressure on the wall above the base in m");
// The answers vary due to round off error


disp("ii)For the long term");
c=5;// in kN/m^2
teta=20;// Slope in degree
H=6;// Vertical height of wall in m
g=18;// Unit weight of soil in kN/m^3
Ka=(1-sind(teta))/(1+sind(teta));// Coefficient of Active Earth Pressure
// At top of the wall
sigmav1=0;// Vertical stress in kN/m^2
sigmaa1=(sigmav1*Ka)-(2*c*sqrt(Ka));// Active pressure in kN/m^2
// At base of the wall
sigmav2=g*H;// Vertical stress in kN/m^2
sigmaa2=(sigmav2*Ka)-(2*c*sqrt(Ka));// Active pressure in kN/m^2
disp(sigmaa2);
z=(2*c*sqrt(Ka))/(g*Ka);// Point at which active earth pressure is zero in m
Pa=0.5*(H-z)*sigmaa2;// Total lateral pressure per metre run of the wall in kN/m
disp(Pa,"    Total lateral pressure per metre run of the wall in kN/m");
Z=(H-z)/3;// Point of application of Lateral pressure on the wall above the base in m
disp(Z,"     Point of application of Lateral pressure on the wall above the base in m");
// The answers vary due to round off error
```

Chapter 23

Sub Structures Foundations

Scilab code Exa 23.1 Angular distortion

```
//Example 23_1
clc;
clear;
close;

//Given data :
Sa=20;// Estimated settlement of structure A(sand) in mm
Sb=36;// Estimated settlement of structure B(clay) in mm

//Structure A
la=6000;// Column spacing in structure A in m
pa=80/100;// Percentage
DSa=pa*Sa;// Differential settlement of structure A in mm
ADa=DSa/la;// Angular distortion of structure A

//Structure B
lb=9000;// Column spacing in structure B in mm
pb=50/100;// Percentage
```

```
DSb=pb*Sb;// Differential settlement of structure B
   in mm
ADb=DSb/lb;// Angular distortion of structure B

if ADa>ADb then
    disp("Structure A experiences the higher angular
        distortion");
elseif ADb>ADa then
    disp("Structure B experiences the higher angular
        distortion");
else
    disp("Both Structures A and B have same angular
       distortion");
end
```

Scilab code Exa 23.2 `Value of Su`

```
//Example 23_2
clc;
clear;
close;

//Given data :
disp("a)");
Su1=15;// Average Undrained shear strength at 1 m
   depth in kN/m^2
Su5=35;// Average Undrained shear strength at 5 m
   depth in kN/m^2
Sud=0.5*(Su1+Su5);// Design Undrained shear strength
    in kN/m^2
disp(Sud," Design Undrained shear strength in kN/m
   ^2");

disp("b)");
// Sub-zone 1:
```

```
disp("Sub−zone 1:");
Su0=10;// Average Undrained shear strength at 0 m depth in kN/mˆ2
Su5=35;// Average Undrained shear strength at 5 m depth in kN/mˆ2
Sud=0.5*(Su0+Su5);// Design Undrained shear strength in kN/mˆ2
disp(Sud," Design Undrained shear strength in kN/mˆ2");
// Sub−zone 2:
disp("Sub−zone 2:");
Su5=35;// Average Undrained shear strength at 5 m depth in kN/mˆ2
Su10=60;// Average Undrained shear strength at 10 m depth in kN/mˆ2
Sud=0.5*(Su5+Su10);// Design Undrained shear strength in kN/mˆ2
disp(Sud," Design Undrained shear strength in kN/mˆ2");
// Sub−zone 3:
disp("Sub−zone 3:");
Su10=60;// Average Undrained shear strength at 10 m depth in kN/mˆ2
Su15=85;// Average Undrained shear strength at 15 m depth in kN/mˆ2
Sud=0.5*(Su10+Su15);// Design Undrained shear strength in kN/mˆ2
disp(Sud," Design Undrained shear strength in kN/mˆ2");
// Sub−zone 4:
disp("Sub−zone 4:");
Su15=85;// Average Undrained shear strength at 15 m depth in kN/mˆ2
Su20=91;// Average Undrained shear strength at 20 m depth in kN/mˆ2
Sud=0.5*(Su15+Su20);// Design Undrained shear strength in kN/mˆ2
disp(Sud," Design Undrained shear strength in kN/m
```

```
^2");
```

Scilab code Exa 23.5 `Type of pile preferred`

```
//Example 23_5
clc;
clear;
close;

//Given data :
Ca=250;// Safe capacity of pile A in kN
Cb=400;// Safe capacity of pile B in kN
Lc=1200;// Corner column load in kN
Li=4000;// Interior column load in kN

disp("If pile A is chosen");
Nc=Lc/Ca;// Number of piles required for corner columns
disp(round(Nc),"  Number of piles required for corner columns");
Ni=Li/Ca;// Number of piles required for corner columns
disp(Ni,"  Number of piles required for interior columns");

disp("If pile B is chosen");
Nc=Lc/Cb;// Number of piles required for corner columns
disp(Nc,"  Number of piles required for corner columns");
Ni=Li/Cb;// Number of piles required for corner columns
disp(Ni,"  Number of piles required for interior columns");
```

Chapter 24

Earth Structures Dams and Embankments

Scilab code Exa 24.2 Selection of soil as transition filter material

```
//Example 24_2
clc;
clear;
close;

//Given data :
D15p=0.001;// D15 protected soil in mm
D85p=0.006;// D85 protected soil in mm

// Soil A:
D15f=0.0025;// D15 filter for soil A in mm
a1=D15f/D15p;
b1=D15f/D85p;

// Soil B:
D15f=0.006;// D15 filter for soil A in mm
a2=D15f/D15p;
b2=D15f/D85p;

```

```
// Soil C:
D15f=0.036;// D15 filter for soil A in mm
a3=D15f/D15p;
b3=D15f/D85p;

if((a1>=5)&&(b1<=5)) then
    disp("Soil A meets all the three criteria and
       can therefore be used for transition filter")
       ;
    elseif((a2>=5)&&(b2<=5)) then
    disp("Soil B meets all the three criteria and
       can therefore be used for transition filter")
       ;
    else((a1>=5)&&(b1<=5))
    disp("Soil C meets all the three criteria and
       can therefore be used for transition filter")
       ;
end
```

Scilab code Exa 24.3 Estimation of Safety Factor

```
//Example 24_3
clc;
clear;
close;

//Given data :
gd=16;// Unit dry weight of soil in kN/m^3
gs=19;// Unit saturated weight of soil in kN/m^3
gw=10;// Unit weigh of water in kN/m^3
b=atand(1/2);// Beta for downstream slope in degree
teta=35;// Slope in degree
SFB=tand(teta)/tand(b);// Safety Factor for soil
   section B
disp(SFB,"Safety Factor for soil section B");
```

```
SFA=((gs-gw)/gs)*(tand(teta)/tand(b));// Safety
    Factor for soil section A
disp(SFA,"Safety Factor for soil section A");
// The answers vary due to round off error
```

Chapter 25

Earth Retaining Structures

Scilab code Exa 25.3 Determination of Safety Factor

```
//Example 25_3
clc;
clear;
close;

//Given data :
H1=4.5;// Height of wall above ground level in m
H2=4.5;// Height of wall below ground level in m
// Above ground level
Ka1=0.33;// Coefficient of Active Earth Pressure
    above ground level
g1=18;// Unit weight of soil above ground level in
    kN/m^3
c1=0;
teta1=30;// Slope above ground level in degree

// Below ground level
Ka2=0.27;// Coefficient of Active Earth Pressure
    below ground level
Kp2=3.68;// Coefficient of Passsive Earth Pressure
    below ground level
```

```
g2=20;// Unit weight of soil below ground level in kN/m^3
c2=0;
teta2=35;// Slope below ground level in degree

sigmaa1=Ka1*g1*H1;// Active pressure above ground level in kN/m^2
sigmaa2=(Ka2*g1*H1)+(g2*H2);// Active pressure below ground level in kN/m^2
sigmap=Kp2*g2*H2;// Passive pressure below ground level in kN/m^2
Pa1=0.5*sigmaa1*H1;// Lateral pressure per metre run of the wall in kN/m
Pa2=sigmaa1*H2;// Lateral pressure per metre run of the wall in kN/m
Pa21=0.5*(sigmaa2-sigmaa1);// Lateral pressure per metre run of the wall in kN/m
Pp=0.5*sigmap*H2;// Lateral pressure per metre run of the wall in kN/m
Mo=(Pa1*(H1+(H1/3)))+(Pa2*H2/2)+(Pa21*H2/3);// Overturning Moment in kNm/m
Mr=Pp*H2/3;// Resisting Momemnt kNm/m
SF=Mr/Mo;// Safety Factor
if(SF>1.5) then
    disp(SF,"Safety Factor is");
else
    disp("Safety factor is 1.50");
end
// The answers vary due to round off error
```

Scilab code Exa 25.4 Earth pressure and lateral pressure

```
//Example 25_4
clc;
clear;
```

```
close;

//Given data :
g=18;// Unit weight of soil in kN/m^3
teta=30;// Slope in degree
c=0;
H=5;// Height in m
Ka=(1-sind(teta))/(1+sind(teta));// Coefficient of
    Active Earth Pressure
// At top of wall
H1=0; // Depth in m
sigmav1=g*H1;// Vertical stress in kN/m^2
sigmaa1=Ka*sigmav1;// Active pressure in kN/m^2
// At 6 m below top of wall
H2=H;// Height in m
sigmav2=g*H2;// Vertical stress in kN/m^2
sigmaa2=Ka*sigmav2;// Horizontal stress in kN/m^2
Pa=0.5*H*sigmaa2;// Lateral pressure per metre run
    of the wall in kN/m
disp(Pa,"Lateral pressure resisted by retaining wall
     per metre run of the wall in kN/m");
Sigmaat=0.65*Ka*g*H;// Active pressure at top of
    excavation in kN/m^2
Sigmaab=0.65*Ka*g*H;// Active pressure at bottom of
    excavation in kN/m^2
Pa=H*Sigmaat;// Lateral pressure per metre run of
    the wall in kN/m
disp(Pa,"Lateral pressure at braced excavation per
    metre run of the wall in kN/m");
disp("The wall of the braced excavation and the
    struts resist a total force of 97.5kN/m which is
    higher than the 75kN/m resisted by the retaining
    wall.");
disp("The earth pressure at the base of the
    retaining wall is higher than the braced
    excavation.");
```

Chapter 26

Earthwork and Earthmoving equipment

Scilab code Exa 26.1 Computation of output of dozer

```
//Example 26_1
clc;
clear;
close;

//Given data :
BC=3;// Blade capacity in m^3
sf=25/100;// Swelling factor
d=50;// Horizontal layer distance in m
fs=2*1000;// Dozer's forward speed in m/hr
rs=5*1000;// Dozer's return speed in m/hr
tf=0.4;// Time for shifting gears in minutes
tp=d/fs*60;// Time for cutting and pushing at forward speed  in minutes
tr=d/rs*60;// Time for returining at return speed in minutes
V=BC/(1+sf);// Volume stripped per cycle in m^3
tc=tp+tr+tf;// Cycle time in minutes
k=0.8;// Efficiency factor(assumption)
```

```
T=k*60/tc;// Trips per hour
O=V*T;// Output per hour in m^3/hr
disp(O,"Output per hour in m^3/hr");
// The answers vary due to round off error
```

Scilab code Exa 26.2 Effect on the output

```
//Example 26_2
clc;
clear;
close;

//Given data :
BC=1.5;// Bucket capacity in m^3
tc=30;// Cycle time in seconds
sf=20/100;// Swell factor of soil
V=9;// Volume of Dumper in m^3
t=120;// Time delay in seconds
Q=0.8*BC/(1+sf)*(3600/tc);// Volume stripped per
    cycle in m^3
N=V/BC;// Number of cycles to load a dumper
at=t/N;// Average delay per cycle in seconds
tc=tc+at;// Cycle time including delay in seconds
O=0.8*BC/(1+sf)*3600/tc;// Output with spotting
    delay in m^3/hr
PO=((Q-O)/Q)*100;// Percentage decrease in output in
     percent
disp(PO,"Percentage decrease in output in percent");
```

Scilab code Exa 26.3 Estimation of number of rollers required

```
//Example 26_3
clc;
```

```
clear;
close;

//Given data :
disp("a)");
w=8;// Width in m
h=3;// Height in m
l=2500;// Length in m
v=2000;// velocity of roller in m/hr
s=1.5/1;// Side slope
V=0.5*h*(w+(w+(2*h*s)))*l;// Volume of earth work in m^3
rw=1.8;// Roller width in m
t=0.45;// Compacted layer thickness in m
n=6;// Number of passes
O1=0.8*rw*v*t/n;// Output of 1 roller in m^3/hr
T=8*30;// Number of hours roller will work in hours
O1m=O1*T;// Output of one roller per month
N=V/O1m;// Number of rollers required
// One extra roller to take care of the breakdown
disp(round(N)+1,"    Hence minimum number of rollers required will be");

disp("b)");
// If each roller will remain idle for 40% time, then the output of the roller per month will be 60% of full output
O1m=0.6*O1m;// Output of one roller per month
N=V/O1m;// Number of rollers required
// One extra roller to take care of the breakdown
disp(round(N)+1,"    Hence minimum number of rollers required will be");
```

Chapter 29

Ground Improvement and Modification

Scilab code Exa 29.1 Determination of most economical method

```
//Example 29_1
clc;
clear;
close;

//Given data :
d=3.5;// Depth of soil in m
l=1;// Length of soil in m
w=1;// Breath of soil in m
V=d*l*w;// Volume in m^3
C1=30;// Cost for excavation per m^3 in Rs.
C2=45;// Cost for relaying soil per m^3 with compaction in Rs.
C=V*(C1+C2);// Cost of excavation and relaying of soil per m^2 in Rs.
disp(C,"Cost of excavation and relaying of soil per m^2 in Rs.");
Cc=350;// Cost of compaction per m^2 in Rs.
disp(Cc,"Cost of compaction per m^2 in Rs.");
```

```
if(C<Cc) then
    disp("Excavation and relaying method is
       econimical");
else
    disp("Impact compaction method is economical");
end
```

Scilab code Exa 29.2 `Cost of treatment`

```
//Example 29_2
clc;
clear;
close;

//Given data :
D1=14;// Initial dry density of soil in kN/m^3
D2=16;// Final dry density of soil in kN/m^3
d=10;// Depth of soil in m
l=1;// Length of soil in m
w=1;// Breath of soil in m
D=D2-D1;// Required increase in dry density of soil
   on kN/m^3
Em=D*d*l*w;// Extra material required per square
   metre of plan area for a depth of 10m in kN
Vm=Em/D2;// Volume of material required per square
   metre in m^3
C=300;// Material cost per m^2 in Rs.
Cm=C*Vm;// Cost of material required per square
   metre in Rs.
Cp=Cm;// Cost of construction of pile in Rs.
TC=Cm+Cp;// Total cost of treatment per square metre
    of plan area in Rs.
disp(TC,"Total cost of treatment per square metre of
    plan area in Rs.");
```

Chapter 30

Insitu Densification of soils

Scilab code Exa 30.2 Cost determination

```
//Example 30_2
clc;
clear;
close;

//Given data :
PC=200*(10^7);// Project cost in Rs.
P=75/100;// Interest percentage
LA=P*PC;//Loan Amount in Rs.
I=(8/100)*(1/12)*LA;// Interest per month on loan in
    Rs.

disp("a)");
T1=1.5;// Time for construction in months(45 days)
EC1=2.75;// Execution Cost in Crore
I1=I/(10^7)*T1;// Interest on Loan Cost in Crore
TC1=EC1+I1;// Total cost in Crore( Execution Cost +
    Interest Cost)
disp(TC1," Total cost in Crore( Execution Cost +
    Interest Cost)");

```

```
disp("b)");
T2=3;// Time for construction in months(90 days)
EC2=2;// Execution Cost in Crore
I2=I/(10^7)*T2;// Interest on Loan Cost in Crore
TC2=EC2+I2;// Total cost in Crore( Execution Cost + Interest Cost)
disp(TC2," Total cost in Crore( Execution Cost + Interest Cost)");

disp("c)");
T3=6;// Time for construction in months(180 days)
EC3=1.6;// Execution Cost in Crore
I3=I/(10^7)*T3;// Interest on Loan Cost in Crore
TC3=EC3+I3;// Total cost in Crore( Execution Cost + Interest Cost)
disp(TC3," Total cost in Crore( Execution Cost + Interest Cost)");

if((TC1<TC2)&&(TC1<TC3)) then
    disp("Option a) is adopted");
    elseif((TC2<TC1)&&(TC2<TC3)) then
    disp("Option b) is adopted");
    elseif((TC3<TC1)&&(TC3<TC2)) then
    disp("Option c) is adopted");
end
```

Scilab code Exa 30.3 Computation of time

```
//Example 30_3
clc;
clear;
close;

//Given data :
T=10;// Thickness of clay in m
```

```
Cc=0.7;
Cvz=0.6;// in m^2/yr
Cvr=1.2;// in m^2/yr

disp("a)");
T90=0.848;// Time factor From figure 9.7
H=5;// Drainage path in m
t90=T90*H*H/Cvz;// Time for 90% consolidation of
    soft clay without sandwicks in years
disp(t90," Time for 90% consolidation of soft clay
    without sandwicks in years");
// The answers vary due to round off error

disp("b)");
S=1;
R=1.06*S/2;// Radius in m
r0=(100/2)/1000;// Radius of sandwick in m
r=R/r0;
// From Table 30.4
// R/r0=10 & T90=0.455
r=10;
T90=0.455;// Time factor
t90=T90*(2*R*2*R)/Cvr;// Time for 90% consolidation
    of soft clay with sandwicks in years
disp(t90," Time for 90% consolidation of soft clay
    with sandwicks in years");
// The answers vary due to round off error
```

Chapter 33

Geosynthetics

Scilab code Exa 33.2 Determination of Safety Factor

```
//Example 33_2
clc;
clear;
close;

//Given data :
// Check for adequacy of water flow across the plane
    of the geotextile
disp("Check for adequacy of water flow across the
   plane of the geotextile");
t=10/1000;// Thickness of geotextile in m
pg=0.05;// Allowable permitivity of geotextile in
   sec^-1
ks=5/(10^8);// k value of soil in m/sec
kg=pg*t;// k value of geotextile in m/sec
FS=kg/ks;// Factor of Safety
disp(FS,"Factor of Safety is");
if(FS>10) then
    disp("Factor of Safety is greater than 10,hence
       OK");
else
```

```
    disp("Factor of Safety is lesser than 10,hence
        adopt it as 10");
end

// Check for retention of soil
D85=0.03;// D85 value in mm
O95=0.04;// O95 value in mm
SF=2.5*D85/O95;// Safety facor
disp(SF,"Safety Factor is");
if(SF>1) then
    disp("Safety Factor is greater than 1,hence OK")
        ;
else
    disp("Safety Factor is lesser than 1,hence adopt
        it as 1");
end
disp("Thus geotextile is suitable as filter");
// The answers vary due to round off error
```

Scilab code Exa 33.3 Determination of Safety Factor

```
//Example 33_3
clc;
clear;
close;

//Given data :
k=1/100000;// k value of soil in m/sec
H=7;// Height in m
nf=6;// Number of flow paths
nd=7;// Number of equipotential drops
w=1;
Q=k*H*nf/nd*w;// Maximum flow rate into the drain in
    m^3/sec
i=1;// Hydraulic gradient within the drain
```

```
tetar=Q/(i*w);// Required transmissivity in m^2/sec

// Case A: nonwoven geotextile
disp("Case A: nonwoven geotextile");
tetaa=2.5/100000;// Allowable transmissivity of geotextile in m^2/sec
SF=tetaa/tetar;// Safety Factor for geotextile
disp(SF,"   Safety Factor for geotextile is");
if(SF>5) then
    disp("   Safety Factor is greater than 5,hence OK");
else
    disp("   Safety Factor is lesser than 5,hence not OK");
end

// Case B: geonet
disp("Case B: geonet");
tetaa=1.2/1000;// Allowable transmissivity of geonet in m^2/sec
SF=tetaa/tetar;// Safety Factor for geonet
disp(SF,"   Safety Factor for geonet is");
if(SF>5) then
    disp("   Safety Factor is greater than 5,hence OK");
else
    disp("   Safety Factor is lesser than 5,hence not OK");
end
// The answers vary due to round off error
```

Scilab code Exa 33.4 Determination of allowable tensile strength and effective len

```
//Example 33_4
clc;
```

```
clear;
close;

//Given data :
disp("a)");
Td=53.3;// Tension developed in reinforcement in kN ( From Example 32.2)
SF=2;// Minimum acceptable Safety Factor
Tall=SF*Td;// Allowable strength of geotextile or geogrid in kN/m
disp(Tall," Allowable strength of geotextile or geogrid in kN/m");

disp("b)");
teta=24;// angle of friction in degree
sigmav=17*9.5;
Le=Tall/(sigmav*tand(teta)*2*1);// Effective length required to prevent slippage in m
disp(Le,"   Effective length required to prevent slippage in m");
// The answers vary due to round off error
```

Chapter 35

Contamination

Scilab code Exa 35.1 Determination of time taken

```
//Example 35_1
clc;
clear;
close;

//Given data :
i=0.007;// Hydraulic gradient causing water flow
k=2/10000;// Coefficient of permeability in m/sec
n=35/100;// Porosity
L=1.5*1000;// Distance between drinking water tube
    well and injection well in m
v=k*i;// in m/sec (From Darcy's law)
vs=v/n;// Seepage velocity in m/sec
t=L/(vs*365*24*60*60);// Time taken for liquid waste
     to reach the drinking water tube well in years
disp(round(t),"Time taken for liquid waste to reach
    the drinking water tube well in years");
```

Scilab code Exa 35.2 Computation of total mass of Chloride ions

```
//Example 35_2
clc;
clear;
close;

//Given data :
c=1500*1000;// Concentration of chloride in the
    leachate in mg/m^3
c1=200*1000;// Concentration of chloride beneath the
     linear in mg/m^3
k=1/(10^9);// Permeability of clay in m/sec
D=0.5/(10^9);// Diffusion Coefficient in m^2/sec
n=0.4;// Porosity of clay
i=-1.3/1;// Hydraulic gradient
JA=-k*i*c;// Advective mass flux in mg/m^2 sec
JD=-D*n*(c1-c);// Diffusive mass flux in mg/m^2 sec
JT=(JA+JD)*3.15*(10^7)/1000;// Total mass flux of
    chloride ions in g/m^2 yr
disp(JT,"Total mass flux of chloride ions in g/m^2
    yr");
// The answers vary due to round off error
```

Chapter 36

Containment of Solid Waste in Landfills

Scilab code Exa 36.1 Computation of quantity of clay and geomembrane required MSW

```
//Example 36_1
clc;
clear;
close;

//Given data :
GS=5*1000000*(0.5-0.3)*365/100;// Municipal solid
    waste(MSW) generation per year in kN/yr
GS1=GS*10;// Municipal solid waste generation(MSW)
    for 10 years in kN
DS=8.5;// Estimated Density of MSW in kN/m^3
VS=GS1/DS;// Volume of MSW in m^3
TS=15;// Thickness of MSW landfill in m
AS=VS/TS;// Approximate Area required MSW landfill
    in m^2
disp(AS,"Approximate Area required MSW landfill in m
    ^2");
// The answer provided in the textbook is wrong

```

```
GH=250000;// Municipal Hazardous waste(MHW) generation per year in kN
GH1=GH*10;// Municipal Hazardous waste(MHW) for 10 years in kN/yr
DH=12;// Estimated Density of MHW in kN/m^3
VH=GH1/DH;// Volume of MHW in m^3
TH=15;// Thickness of MHW landfill in m
AH=VH/TH;// Approximate Area required MHW landfill in m^2
disp(AH,"Approximate Area required MHW landfill in m^2");
// The answer provided in the textbook is wrong

tl=0.90;// Layer of thickness in liner in m
tc=0.60;// Layer of thickness in cover in m
VC=(tl+tc)*AS;// Approximate quantity of clay required for MSW landfill in m^3
disp(VC,"Approximate quantity of clay required for MSW landfill in m^3");
// The answer provided in the textbook is wrong
VG=(tl+tc)*AS;// Approximate quantity of geomembrane required for MSW landfill in m^3
disp(VG,"Approximate quantity of geomembrane required for MSW landfill in m^3");
// The answer provided in the textbook is wrong
```

Scilab code Exa 36.3 Computation of tension in geomembrane

```
//Example 36_3
clc;
clear;
close;

//Given data :
b=atand(1/2.5);// Beta in degree
```

```
sc=10;// Sigma in degree
SF=tand(sc)/tand(b);// Safety Factor
disp(SF,"Safety Factor is");
if(SF<1) then
    disp("Geomembrane will slide without anchorage")
        ;
else
    disp("Geomembrane will not slide without
        anchorage");
end
D=9.4;// Density of HDPE in kN/m^3
T=1.5/1000;// Thickness of geomembrane in m
TS=18;// Tensile Strength at yield in kN/m
d=10;// depth in m
L=d/sind(b);// Length in m
Wg=D*T*L;// Weight of geomembrane in kN/m
D=Wg*sind(b);// Driving Force in kN/m
R=Wg*cosd(b)*tand(sc);// Resisting Force in kN/m
Tg=D-R;// Tension in geomembrane in kN/m
disp(Tg,"Tension in geomembrane in kN/m");
if(Tg<TS) then
    disp("Hence safe in tension");
else
    disp("Hence not safe in tension");
end
// The answers vary due to round off error
```

Scilab code Exa 36.4 Computation of tension in geomembrane

```
//Example 36_4
clc;
clear;
close;

//Given data :
```

```
SF=1.5;// Safety Factor
sc=21;// Angle of interface shearing resistance in degree
b=round(atand(tand(sc)/SF));// Beta in degree
L=30;// Length in m
tt=0.6;// Thickness of top soil in m
td=0.3;// Thickness of drainage layer in m
uw=17;// Unit weight of top soil and drainage layer in kN/m^3
D=9.4;// Density of HDPE in kN/m^3
sc=10;// Angle of geomembrane-clay interface resistance in degree
T=1.5/1000;// Thickness of geomembrane in m
Ws=L*(tt+td)*uw;// Weight of soil in kN/m
Wg=L*D*T;// Weight of geomembrane in kN/m
D=Ws*sind(b);// Driving Force in kN/m
R=Ws*cosd(b)*tand(sc);// Resisting Force in kN/m
Tg=round(D-R);// Tension in geomembrane in kN/m
disp(Tg,"Tension in geomembrane in kN/m");
disp("Geomembrane can fail in tension it its tensile strength is less than 33 kN/m");
```

Chapter 37

Containment of Slurry Wastes

Scilab code Exa 37.2 Determination of Safety Factor

```
//Example 37_2
clc;
clear;
close;

//Given data :
// When the water level in the pond is low and the
   phreatic line is well away from the downstream
   face, the slope is considered to be dry.
disp("a)");
cdash=0;
t=30;// Teta in degree
b=18;// Beta in degree
SF=tand(t)/tand(b);// Safety Factor
disp(SF,"Safety Factor is");
// The answers vary due to round off error

// When the water level in the pond is high and the
   phreatic line meets the downstream slope well
   above the toe of the downstream face.
disp("b)");
```

```
gd=8;// Dry Unit weight in kN/m^3
gs=18;// Saturated Unit weight in kN/m^3
SF=(gd/gs)*(tand(t)/tand(b));// Safety Factor
disp(SF,"Safety Factor is");
// The answers vary due to round off error
disp("It may be noted that the slope is stable when
    the water level in the pond is low (Safety Factor
     = 1.75) but the Safety Factor reduces to 45% of
    the orignal value and to an unsafe value when the
     water level becomes high and phreatic line
    reaches the downstream face. Hence it is
    essential to provide internal drains.");
```

Chapter 38

Vertical Barriers for Containment

Scilab code Exa 38.1 `Cost determination`

```
//Example 38_1
clc;
clear;
close;

//Given data :
Ca=200;// Cost of ammended soil barrier(horizontal) in Rs per m^3
Cg=250;// Cost of geomembrane in Rs per m^2
Cb=350;// Cost of soil-Bentonite barrier(vertical) in Rs per m^3
Ta=1;// Thickness of compacted ammended soil in m
Tg=1.5/1000;// Thickness of geomembrane in m
Tb=1.2;// Thickness of soil-Bentonite in m

// Alternative A
disp("Alternative A");
L=200;// Length if landfill in m
B=150;// Breath of landfill in m
```

```
Aa=L*B;// Area of landfill in m^2
Va=Aa*Ta;// Volume of ammended soil barrier layer in
    m^3
CA=Va*Ca;// Cost of ammended soil barrier layer in
    Rs
Ag=L*B;// Area of geomembrane in m^2
CG=Ag*Cg;// Cost of geomembrane in Rs
TC=CA+CG;// Total cost of liner in Rs
disp(TC,"   Total cost of liner in Rs");

// Alternative B
disp("Alternative B");
L=220;// Length of trench wall in m
B=190;// Wdith of trench wall in m
P=2*(L+B);// Perimeter of in m
d=12;// Depth in m
V=P*Tb*d;// Volume of cut-off wall in m^3
C=V*Cb;// Cost of cut-off wall in Rs
disp(C,"    Cost of cut-off wall in Rs");
if(TC<C) then
    disp("Cost of liner is less than cost of cut-off
        . Hence cost of liner is chosen");
else
    disp("Cost of cut-off is less than cost of liner
        . Hence cost of cut-off is chosen");
end
```

Chapter 40

Soil Behaviour Under Dynamic Loads and Applications

Scilab code Exa 40.2 Finding natural period of vibration of the machine

```
//Example 40_2
clc;
clear;
close;

//Given data :
m=200;// Mass of milling machine in kg
k=1*10^6;// Stiffness in N/m
wn=sqrt(k/m);// Natural frequency of vibration of
    the machine in rad/sec
Tn=2*3.14/wn;// Natural time period of vibration of
    the machine in sedonds
disp(Tn,"Natural time period of vibration of the
    machine in sedonds");
// The answers vary due to round off error
```

Scilab code Exa 40.3 `Determination of maximum velocity and acceleration`

```
//Example 40_3
clc;
clear;
close;

//Given data :
x=2;// Amplitude in mm
T=0.15;// Period in seconds
w=2*3.14/T;// Natural frequency of vibration in rad/sec
v=w*x;// Maximum velocity in mm/sec
disp(v,"Maximum velocity in mm/sec");
a=w*w*x/1000;// Maximum accleration in m/sec^2
disp(a,"Maximum accleration in m/sec^2");
// The answers vary due to round off error
```

Chapter 41

Machine Foundations

Scilab code Exa 41.1 Percentage change in Cu

```
//Example 41_1
clc;
clear;
close;

//Given data :
Cu=20000;// Coefficient of elastic uniform
    compression of a soil in kN/m^3
Af=4;// Area of block in m^2
Al=Af/2;// Area of block halved in m^2
Cul=Cu*sqrt(Af/Al);// New Coefficient of elastic
    uniform compression of a soil in kN/m^3
P=(Cul-Cu)/Cu*100;// Percentage increase in
    Coefficient of elastic uniform compression of a
    soil
disp(P,"Percentage increase in Coefficient of
    elastic uniform compression of a soil");
// The answers vary due to round off error
```

Scilab code Exa 41.2 Determination of natural frequency of machine foundation

```
//Example 41_2
clc;
clear;
close;

//Given data :
Af=2*2;// Area in m^2
Cu=20000;// Coefficient of elastic uniform
    compression in kN/m^3
kz=Cu*Af;// Stiffness in the vertical directon in kN
    /m
W=125;// Weight of machine in kN
g=9.81;// Accleration due to gravity in m/sec^2
m=W/g;// Mass of machine in kg
wn=sqrt(kz/m);// Natural frequency of vibration in
    rad/sec
fn=1/(2*3.14)*wn;// Natural frequency of machine in
    Hz
disp(fn,"Natural frequency of machine in Hz");
// The answers vary due to round off error
```

Scilab code Exa 41.3 Determination of natural frequency of machine foundation

```
//Example 41_3
clc;
clear;
close;

//Given data :
Wf=1000;// Weight of foundation in kN
Wm=400;// Weight of machine in kN
TW=Wf+Wm;// Total Weight in kN
g=9.81;// Accleration due to gravity in m/sec^2
```

```
m=TW/g;// Mass of foundation in kg
Cu=100000;// Coefficient of elastic uniform compression for the soil in kN/m^3
Af=25;// Area of foundation block in m^2
k=Cu*Af;// Stiffness in kN/m
fn=1/(2*3.14)*sqrt(k/m);// Natural frequency on machine in Hz
disp(fn,"Natural frequency on machine in Hz");
// The answers vary due to round off error

// (a) Natural frequency when the weights are kept constant and the foundation area is doubled
disp("a)");
Af1=2*25;// Area of foundation block in m^2
k1=Cu*Af;// Stiffness in kN/m
fn1=1/(2*3.14)*sqrt(k1/m);// Natural frequency on machine in Hz
disp(fn1,"Natural frequency on machine in Hz");
// The answers vary due to round off error

// (b) Natural frequency when the area is kept constant and the weight is doubled
disp("b)");
m2=2*m;// Mass of foundation in kg
fn2=1/(2*3.14)*sqrt(k/m2);// Natural frequency on machine in Hz
disp(fn2,"Natural frequency on machine in Hz");
// The answers vary due to round off error
```

Scilab code Exa 41.4 Determination of coefficient of elastic uniform compression

```
//Example 41_4
clc;
clear;
close;
```

```

//Given data :
fn=15;// Resonant frequency in Hz
A=1.5*0.75;// Area of concrete test block A in m^2
UW=24;// Unit Weight of concrete in kN/m^3
W=A*0.75*UW;// Weight of concrete block in kN
g=9.81;// Accleration due to gravity in m/sec^2
m=W/g;// Mass of concrete block in kg
Cu=((fn*2*3.14)^2)*m/A;// Coefficient of elastic
    uniform compression in kN/m^3
disp(Cu,"Coefficient of elastic uniform compression
    in kN/m^3");
// The answer provided in the textbook is wrong
// Al=6*6=36 m^2
// However we limit the value of Al=10 m^2
Al=10;// Area of block in m^2
Cul=sqrt(Cu*Cu*Al/A);// New Coefficient of elastic
    uniform compression in kN/m^3
Wb=6*6*2.5*UW;// Weight of rigid foundation block in
     kN
W=100;// Weight of machine in kN
TW=Wb+W;// Total weight in kN
m=W/g;// Mass in kg
fn=1/(2*3.14)*sqrt(Cul*6*6/m);// Natural frequency
    in vertical vibrations in Hz
disp(fn,"Natural frequency in vertical vibrations in
     Hz");
// The answer provided in the textbook is wrong
```

Scilab code Exa 41.5 Determination of the value of Cu and the fraction of critical

```
//Example 41_5
clc;
clear;
close;
```

```
//Given data :
fn=14.2;// Resonant frequency in Hz (From the graph
    in Fig. 41.7)
A=1*1;// Area of concrete test block A in m^2
UW=24;// Unit Weight of concrete in kN/m^3
W=1*1*1*UW;// Weight of concrete block in kN
g=9.81;// Accleration due to gravity in m/sec^2
m=W/g;// Mass of block in kg
Cu=((fn*2*3.14)^2)*m/A;// Coefficient of elastic
    uniform compression in kN/m^3
disp(Cu,"Coefficient of elastic uniform compression
    in kN/m^3");
// The answers vary due to round off error

// From Fig. 41.7
f2=925;// in rpm
f1=775;// in rpm
fnz=850;// in rpm
C=(f2-f1)/(2*fnz);// Fraction of critical damping
C=C*100;// Critical damping in %
disp(C,"Critical damping in % is");
// The answers vary due to round off error
```

Chapter 42

Earthquake Engineering

Scilab code Exa 42.6 `Determination of cyclic shear stress and cyclic shear resista`

```
//Example 42_6
clc;
clear;
close;

//Given data :
gt=18.9;// Total Unit weight in kN/m^3
gs=8.9;// Unit weight of subsurface in kN/m^3
z=3;// Depth of interest in m
rd=1-(0.00765*z);// Stress reduction factor
amax=0.40;// Peak ground acceleration in g
g=9.81;// Accleration due to gravity in m/sec^2
tav=0.65*gt*z/g*amax*rd;// Cyclic shear stress induced during earthquake in kN/m^2
disp(tav,"Cyclic shear stress induced during earthquake in kN/m^2");
sv=41.7;// sigma dash v at depth of 3.0 m in kN/m^2
// The answer provided in the textbook is wrong
M=0.1;// Magnitude of earthquake
tcyc=M*sv;// Cyclic shear resistance available during earthquake in kN/m^2
```

```
disp(tcyc,"Cyclic shear resistance available during
   earthquake in kN/m^2");

if (tav>tcyc) then
    disp("Since the cyclic shear stress induced
       during earthquake is more than the cyclic
       shear resistance available, the soil at depth
        of 3 m will liquefy");
else
    disp("Since the cyclic shear stress induced
       during earthquake is less than the cyclic
       shear resistance available, the soil at depth
        of 3 m will not liquefy");
end
// The answer provided in the textbook is wrong
```

Scilab code Exa 42.7 Calculation of Safety Factor

```
//Example 42_7
clc;
clear;
close;

//Given data :
b2=30;// in m
b1=20;// in m
b=b2-b1;// Base in m
h=10;// Height in m
A=1/2*b*h;// Area of failure wedge in m^2
gt=18;// Total Unit weight in kN/m^3
c=15;// in kPa
teta=0;// Angle in degree
W=A*gt;// Weight of failure wedge per metre length
   in kN/m
L=sqrt((h*h)+(b2*b2));// Length of the slip surface
```

```
in m
b=atand(h/b2);// Inclination of the failure wedge in degree

// Safety Factor under static condition
SF=((c*L)+(W*cosd(b)*tand(teta)))/(W*sind(b));// Safety Factor under static condition
disp(SF,"Safety Factor under static condition is");
// The answers vary due to round off error

// Dynamic factor of Safety under seismic condition
kh=0.3;// Pseudostatic seismic coefficient
Fh=kh*W;// Static force acting horizontally in kN
DFS=((c*L)+(((W*cosd(b))-(Fh*sind(b)))*tand(teta)))/((W*sind(b))+(Fh*cosd(b)));// Dynamic Factor of Safety under seismic condition
disp(DFS,"Dynamic Factor of Safety under seismic condition");
// The answers vary due to round off error
```

Scilab code Exa 42.8 Calculation of Critical acceleration of the slope

```
//Example 42_8
clc;
clear;
close;

//Given data :
b2=30;// in m
b1=20;// in m
b=b2-b1;// Base in m
h=10;// Height in m
A=1/2*b*h;// Area of failure wedge in m^2
gt=18;// Total Unit weight in kN/m^3
c=15;// in kPa
```

```
teta=0;// Angle in degree
W=A*gt;// Weight of failure wedge per metre length in kN/m
L=sqrt((h*h)+(b2*b2));// Length of the slip surface in m
b=atand(h/b2);// Inclination of the failure wedge in degree
DFS=1;// Dynamic Factor of Safety under seismic condition
// Where Fh = kh
// Since tan(0) = 0, ((W*cosd(b))-(Fh*sind(b)))*tand(teta)) = 0
Fh=((c*L)-(W*sind(b)))/(cosd(b));// Static force acting horizontally in kN
kh=Fh/W;// Pseudostatic seismic coefficient
// kh= ac/g
g=9.81;// Acceleration due to gravity in m/s^2
ac=kh*g;// Critical acceleration in m/s^2
disp(ac,"Critical acceleration in m/s^2");
// The answer provided in the textbook is wrong
```