FIRM:DesignCalcs, Inc. JOB NO. SHEET NO: 1
MADE BY:KJH DATE:02-28-2013 CHECKED BY: DATE:
TITLE:SEEPAGE Program Example Output

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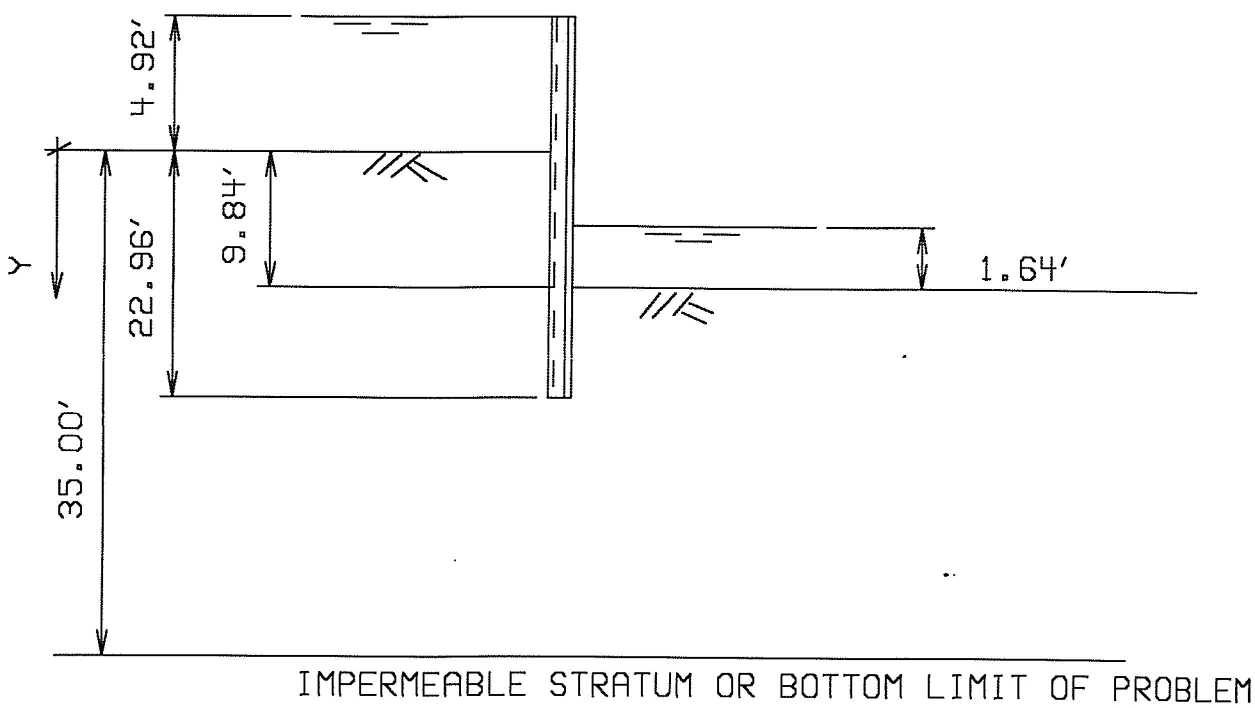
SEEPAGE FLOW FILE ANALYSIS:



Analysis Methology:

Design Reference: "Physical Behavior in Geotechnics" by Fethi Azizi
(c) 2007, Chapters 4 and 6.

For the case of anisotropic flow, the modified Laplace equation is,
$k_x \, \delta^2 h/\delta x^2 + k_y \, \delta^2 h/\delta y^2 = 0$ (Ref. Eq. 4.47)

where,
h=hydraulic head measured from an arbitrary datum
k_x = permeability coefficient in the x-direction
k_y = permeability coefficient in the y-direction

This program solves the Laplace equation using an iterative finite difference method until the solution converges (see next sheet).

Soil Permeability Coefficients:

Layer No.	Thickness (ft)	k_x (mm/sec)	k_y (mm/sec)
1	35.00	0.0099999997	0.0099999997

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SEEPAGE FLOW FILE ANALYSIS:

Description of the Iterative Solution Method:

1. The soil mass is discretized into uniformly spaced nodes.
2. Known head values are assigned at boundaries(Dirchlet condition)
3. At other boundaries, the gradient head is known (Neumann condition)
4. A computation molecule is applied to all nodes inside the boundaries:

```
                     h(i,j+1)
                     (A4)<--(coefficient)
                        |
h(i-1,j)  (A1)------(B)---------(A2)  h(i+1,j)
                        | h(i,j)<--(head at node i,j)
                     (A3)
                     h(i,j-1)
```

Computational Molecule

(See Ref. 1 Fig. 6.13)

$h_{i,j}$ = 1/B * [(A1)*$h_{i-1,j}$ + (A2)*$h_{i+1,j}$ + (A3)*$h_{i,j-1}$ + (A4)*$h_{i,j+1}$]

For nodes spaced equidistantly,
B=2+2*C
A1=C, A2=C, A3=1, A4=1
where C=k_x / k_y (See "Theory of Elasticity" by Timoshenko, p. 520)

Iterating the above, the error between steps for all nodes is computed as,

Error = ABS{($h_{i,j}$ - Previous $h_{i,j}$))/$h_{i,j}$ }

The maximum error printed is the maximum error of all nodes.

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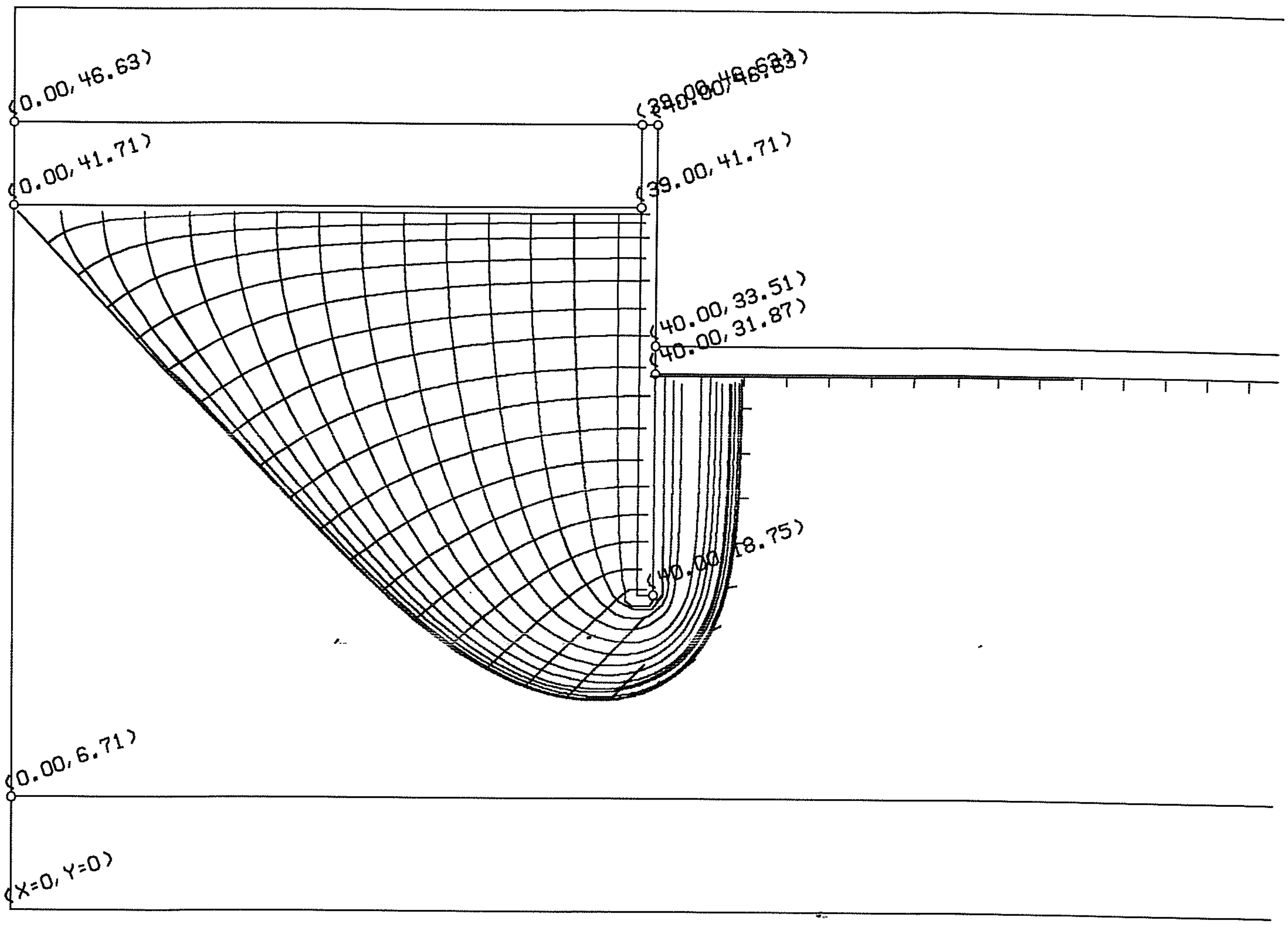
SEEPAGE FLOW FILE ANALYSIS:



Node spacing: DX= .533 ft, DY= .533 ft
Results after 1000 interations:
Maximum error = .14400

Maximum vertical hydraulic gradient, $i = h/\delta y =$ .5992
occurring next to sheeting at 12.27 ft below dredgeline

Maximum seepage flow velocity= 0.00000753 ft/sec
Seepage rate = 0.09397496 gallons/hour per foot width

Check for Quicksand Condition:

To avoid a quick condition, the gradient must be less than the a critical gradient value of,

$i_{cr} = (\gamma_{sat} - \gamma_w)/\gamma_w$ (Ref. 4.22)

A safety factor of at least 3 (ideally 4) should be used.

In this case the following saturated weight of sand was entered,
γ_{sat} = 100.00 pcf

SEEPAGE FLOW FILE ANALYSIS:

Heads Computed at Various Points (Units=Feet):

Location Y \X->	.27	2.93	5.60	8.27	10.93	13.60	16.27	18.93
41.87	4.92	4.92	4.92	4.92	4.92	4.92	4.92	4.92
39.20	4.92	4.84	4.77	4.69	4.63	4.57	4.51	4.47
36.53	4.92	4.77	4.62	4.47	4.34	4.22	4.11	4.02
33.87	4.92	4.69	4.47	4.26	4.07	3.89	3.73	3.60
31.20	4.92	4.63	4.34	4.07	3.81	3.58	3.38	3.20
28.53	4.92	4.56	4.22	3.89	3.58	3.30	3.06	2.84
25.87	4.92	4.51	4.11	3.73	3.38	3.06	2.77	2.52
23.20	4.92	4.46	4.02	3.60	3.20	2.85	2.53	2.24
20.53	4.92	4.43	3.94	3.49	3.06	2.67	2.32	2.01
17.87	4.92	4.39	3.88	3.40	2.94	2.53	2.16	1.83
15.20	4.92	4.37	3.84	3.33	2.86	2.42	2.03	1.69
12.53	4.92	4.35	3.80	3.28	2.79	2.35	1.95	1.59
9.87	4.92	4.34	3.78	3.25	2.76	2.30	1.89	1.53
7.20	4.92	4.34	3.78	3.24	2.74	2.29	1.87	1.51
4.53	*	*	*	*	*	*	*	*

Location Y \X->	21.60	24.27	26.93	29.60	32.27	34.93	37.60	40.27
41.87	4.92	4.92	4.92	4.92	4.92	4.92	4.92	*
39.20	4.43	4.39	4.36	4.34	4.33	4.31	4.31	*
36.53	3.94	3.87	3.82	3.77	3.74	3.72	3.71	*
33.87	3.48	3.38	3.29	3.23	3.17	3.14	3.12	*
31.20	3.04	2.91	2.80	2.70	2.63	2.58	2.55	-7.98
28.53	2.65	2.48	2.34	2.22	2.12	2.04	2.00	-6.89
25.87	2.29	2.10	1.93	1.77	1.63	1.52	1.46	-5.80
23.20	1.99	1.77	1.56	1.37	1.18	1.00	.88	-4.74
20.53	1.74	1.48	1.25	1.02	.77	.48	.17	-3.65
17.87	1.53	1.26	1.00	.73	.43	0.03	-.61	-2.03
15.20	1.38	1.09	.81	.53	.21	-.20	-.76	-1.46
12.53	1.27	.97	.69	.40	0.08	-.29	-.73	-1.20
9.87	1.20	.90	.62	.33	0.02	-.31	-.68	-1.06
7.20	1.18	.88	.59	.31	0.00	-.32	-.66	-1.01
4.53	*	*	*	*	*	*	*	*

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SEEPAGE FLOW FILE ANALYSIS:

Heads Computed at Various Points (Units=Feet):

Location Y \X->	42.93	45.60	48.27	50.93	53.60	56.27	58.93
41.87	*	*	*	*	*	*	*
39.20	*	*	*	*	*	*	*
36.53	*	*	*	*	*	*	*
33.87	*	*	*	*	*	*	*
31.20	-7.98	-7.98	-7.99	-7.99	-7.99	-7.99	-8.00
28.53	-6.89	-6.90	-6.92	-6.94	-6.96	-6.97	-6.98
25.87	-5.81	-5.85	-5.89	-5.93	-5.96	-5.98	-6.00
23.20	-4.76	-4.83	-4.91	-4.97	-5.02	-5.06	-5.09
20.53	-3.72	-3.88	-4.01	-4.11	-4.18	-4.23	-4.26
17.87	-2.73	-3.04	-3.23	-3.36	-3.45	-3.51	-3.56
15.20	-2.03	-2.38	-2.61	-2.76	-2.87	-2.94	-2.99
12.53	-1.62	-1.94	-2.17	-2.33	-2.44	-2.51	-2.57
9.87	-1.40	-1.68	-1.90	-2.06	-2.17	-2.25	-2.31
7.20	-1.33	-1.60	-1.81	-1.97	-2.08	-2.16	-2.21
4.53	*	*	*	*	*	*	*

Location Y \X->	64.27	66.93	69.60	72.27	74.93	77.60	79.73
41.87	*	*	*	*	*	*	*
39.20	*	*	*	*	*	*	*
36.53	*	*	*	*	*	*	*
33.87	*	*	*	*	*	*	*
31.20	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00	-8.00
28.53	-6.99	-7.00	-7.00	-7.00	-7.00	-7.00	-7.00
25.87	-6.02	-6.03	-6.03	-6.03	-6.04	-6.04	-6.04
23.20	-5.12	-5.13	-5.13	-5.13	-5.14	-5.14	-5.14
20.53	-4.30	-4.31	-4.32	-4.32	-4.33	-4.33	-4.33
17.87	-3.60	-3.62	-3.62	-3.63	-3.63	-3.63	-3.63
15.20	-3.04	-3.05	-3.06	-3.07	-3.07	-3.07	-3.07
12.53	-2.62	-2.64	-2.65	-2.65	-2.66	-2.66	-2.66
9.87	-2.37	-2.38	-2.39	-2.40	-2.40	-2.40	-2.40
7.20	-2.27	-2.29	-2.30	-2.31	-2.31	-2.31	-2.31
4.53	*	*	*	*	*	*	*