53:030 SOIL MECHANICS

Department of Civil & Environmental Engineering
The University of Iowa
Fall Semester 2003

Midterm Exam #2, 1 hour
3 questions, 100 points

Question #1: (45 points)

A wastewater aeration tank of diameter 40m and gross weight 286.5MN is to be constructed on the site shown below in Figure 1a. To construct the tank, 6m of the dense sand layer will be excavated and the tank will be built as shown in Figure 1b. For the values provided for the soil:

a. Compute the increased average vertical stress in the clay layer directly beneath the center of the tank;
b. Calculate the ultimate consolidation settlement that would be expected to occur under the net additional loading created by the tank;
c. How long would it take for 75% of this consolidation settlement to occur? (Assume the one-dimensional consolidation model is valid.)

Diagram not to scale.

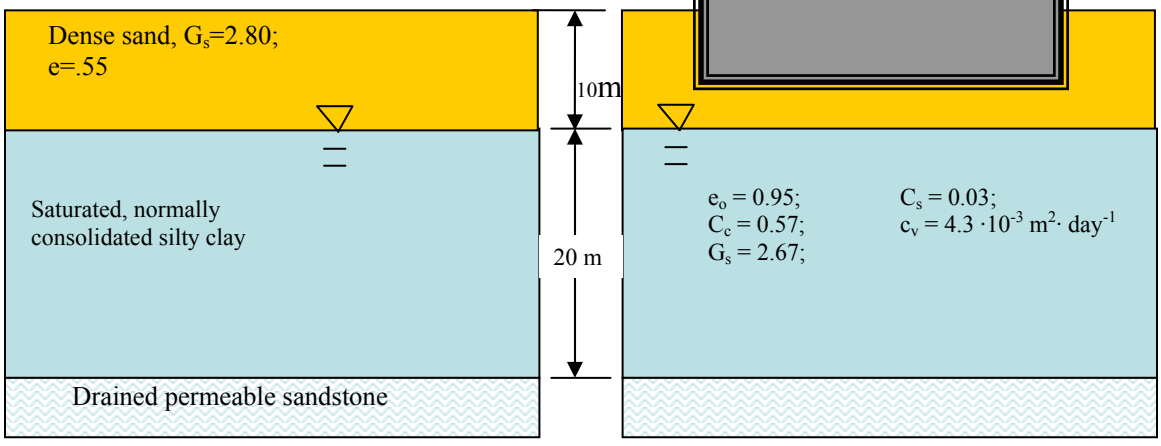


Fig. 1a Fig. 1b

Note: $\Delta\sigma_v = q\left\{1-\left[\left(R/z\right)^2+1\right]^{-1.5}\right\}$ where R is the radial dimension of the loaded area and z is the distance below the center of the loaded area.

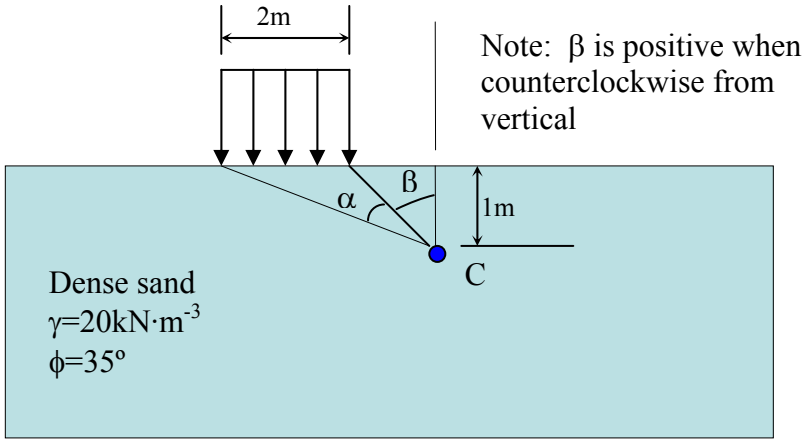
Question #2: (45 points)

At a point C in the soil mass before any loads are applied, the vertical effective stress σ_v' and horizontal effective stress σ_h' are 100 kPa and 50 kPa, respectively.

Subsequently, a strip load of magnitude q=200 kPa and width B=2m is applied **directly over** point C.

a. What is the maximum shear stress at C **before** the strip load is applied?
b. **After** the strip load is applied, what are the vertical and horizontal stresses at point C?
c. What magnitude of strip load would be required to generate shear failure in the soil at point C?
d. If failure were to occur at C due to the strip loading, what would be the orientation of the plane(s) on which shear failure might be expected? (Use Pole method).
e. What would be the magnitude of the shear and normal stresses at failure? (Use Pole method)

$$\Delta\sigma_v = \frac{q}{\pi}\left[\alpha + \sin(\alpha)\cos(\alpha + 2\beta)\right]$$
$$\Delta\sigma_h = \frac{q}{\pi}\left[\alpha - \sin(\alpha)\cos(\alpha + 2\beta)\right]$$



Question #3 (10 points):

Identify all of the relevant assumptions made in developing the standard one-dimensional soil consolidation model (i.e. the model that you were asked to use in Question #1).

Tabulated values of degree of consolidation U(%) versus non-dimensional time factor T_v in the one-dimensional consolidation model.

U(%)	T_v	U(%)	T_v	U(%)	T_v
0	0	34	.0907	68	.377
1	.00008	35	.0962	69	.390
2	.00030	36	.102	70	.403
3	.00071	37	.107	71	.417
4	.00126	38	.113	72	.431
5	.00196	39	.119	73	.446
6	.00283	40	.126	74	.461
7	.00385	41	.132	75	.477
8	.00502	42	.138	76	.493
9	.00636	43	.145	77	.511
10	.00785	44	.152	78	.529
11	.00950	45	.159	79	.547
12	.01130	46	.166	80	.567
13	.0133	47	.173	81	.588
14	.0154	48	.181	82	.610
15	.0177	49	.188	83	.633
16	.0201	50	.197	84	.658
17	.0227	51	.204	85	.684
18	.0254	52	.212	86	.712
19	.0283	53	.221	87	.742
20	.0314	54	.230	88	.774
21	.0346	55	.239	89	.809
22	.0380	56	.248	90	.848
23	.0415	57	.257	91	.891
24	.0452	58	.267	92	.938
25	.0491	59	.276	93	.993
26	.0531	60	.286	94	1.055
27	.0572	61	.297	95	1.129
28	.0615	62	.307	96	1.219
29	.0660	63	.318	97	1.336
30	.0707	64	.329	98	1.500
31	.0754	65	.340	99	1.781
32	.0803	66	.352	100	∞
33	.0855	67	.364		