53:030 SOIL MECHANICS

Department of Civil & Environmental Engineering
The University of Iowa
Fall Semester 2002

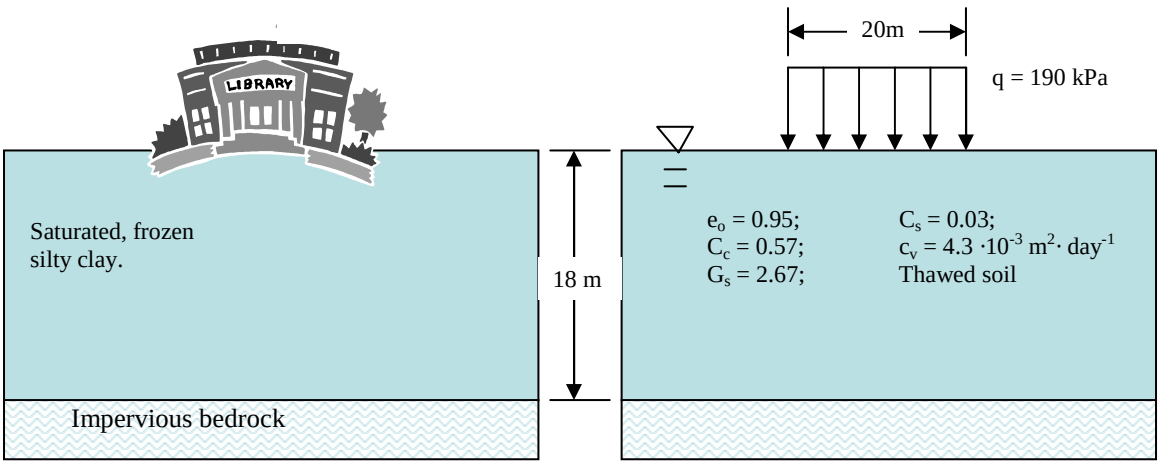
Midterm Exam #2, 1 hour
3 questions, 100 points

Question #1: (45 points)

Not so long ago, the city of Köldengrad, Siberia built their library on permafrost soil as shown in Figure 1. As long as the soil remains frozen, the settlements associated with the structural load on the soil are negligible. With the gradual onset of global warming, however, the city engineer is concerned that the structural bearing loads on the thawing soil will cause excessive settlements.

a) Given the properties measured for the thawed soil, which is normally consolidated, estimate the eventual consolidation settlements that will occur beneath the center of the library which is built on a circular flexible slab foundation of radius 10 m.

b) Using a one-dimensional consolidation model, estimate how long would it take for 60 % of the primary consolidations to occur if the soil were to thaw instantaneously. [Please see page 3 for additional information.]



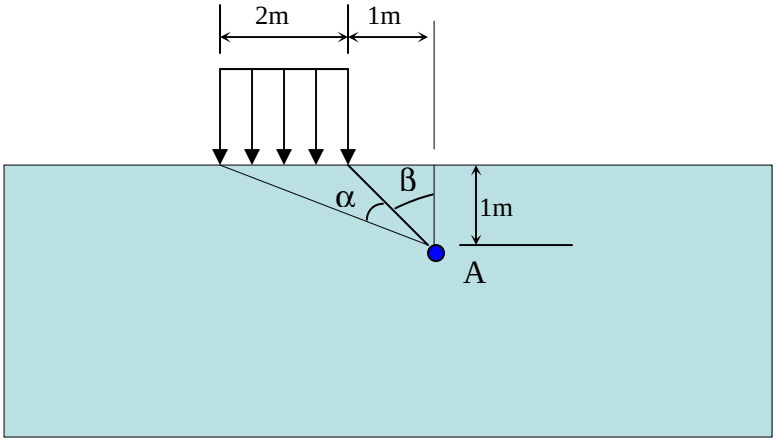
$\Delta\sigma_v = q\left\{1-\left[\left(R/z\right)^2+1\right]^{-1.5}\right\}$ where R is the radial dimension of the loaded area.

Question #2: (45 points)

A strip load is applied to a soil as shown in the Figure below. Neglect any initial stresses in the soil.

a) Using the formulas provided, compute the stress increases $(\Delta\sigma_{zz}, \Delta\sigma_{xx}, \Delta\tau_{xz},)$ at point A in terms of the applied strip load of magnitude *q*;
b) Compute the magnitude of the principal stresses σ'_1 and σ'_3 at point A using Mohr's circle analysis;
c) Using the pole method, compute the respective orientations of the principal planes passing through point A.
d) If the soil has a drained friction angle $\phi' = 15^\circ$ and cohesion $c = 50$ kPa , compute the magnitude q_u of the strip loading that initiates shear failure at point A.

$$\Delta\sigma_{zz} = \frac{q}{\pi}\left[\alpha + \sin(\alpha)\cos(\alpha + 2\beta)\right]$$
$$\Delta\sigma_{xx} = \frac{q}{\pi}\left[\alpha - \sin(\alpha)\cos(\alpha + 2\beta)\right]$$
$$\Delta\tau_{xz} = \frac{q}{\pi}\left[\sin(\alpha)\sin(\alpha + 2\beta)\right]$$



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).

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		