UNIVERSITY OF JOHANNESBURG

PROGRAM	:	BACCALAUREUS INGENERIAE *CIVIL ENGINEERING*
SUBJECT	:	**GEOTECHNICAL ENGINEERING 3A**
CODE	:	**GTG3B21**
DATE	:	SUPPLEMENTARY EXAMINATION NOV 2014
DURATION	:	08:30 - 11:30
WEIGHT	:	50:50
TOTAL MARKS	:	100

EXAMINER	:	DR FN OKONTA
MODERATOR	:	DR HA QUAINOO
NUMBER OF PAGES	:	3 PAGES AND 2 ANNEXURES

INSTRUCTIONS : QUESTION PAPERS MUST BE HANDED IN.

INSTRUCTIONS TO CANDIDATES:

PLEASE ANSWER ALL THE QUESTIONS.
PLEASE NUMBER ALL QUESTIONS EXACTLY AS QUESTION PAPER.

QUESTION 1 (20 MARKS)

1.1) Figure 1 show a foundation with an inner diameter of 1.5m and an outer diameter of 4m, if the contact pressure is 100kPa, compute the vertical induced stress at point A, 5m into the ground. (13)

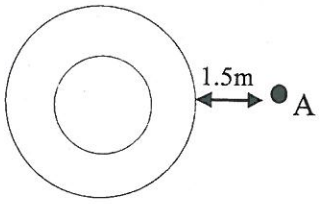

Figure 1: Foundation geometry (plan view)

1.2). Discuss the differences in computing the induced stresses using equations and charts highlighting associated difficulties and/or limitations of the methods. (7)

QUESTION 2 (20 MARKS)

2.1) Some Geotechnical Engineering textbooks indicate that for settlement analysis it is conservative to consider a partially saturated sand layer as fully saturated and normally consolidated, as it tends to simulate a worst case scenario. Do you agree that an overconsolidated case 2 is even more conservative? (7)

2.2) A 1.00m^3 element of soil is located below the groundwater table. When a new compressive load was applied, the element consolidated, producing a vertical strain, ε_z = 8.5%. Assume the horizontal strain was zero and compute the volume of water squeezed out of the soil during consolidation.
(13)

QUESTION 3 (20 MARKS)

3.1) a) Discuss the graphical determination of preconsolidation stress, and highlight related challenges in its determination
(5)

3.2). A 4.0m thick fill is to be made of a soil with a Proctor maximum dry unit weight of 19.4kN/m^3 and optimum moisture content of 13%. This fill will be compacted to an average relative compaction of 92%. The overlying soils profile are shown in figure 2. Determine the ultimate settlement due to the weight of fill.
(15)

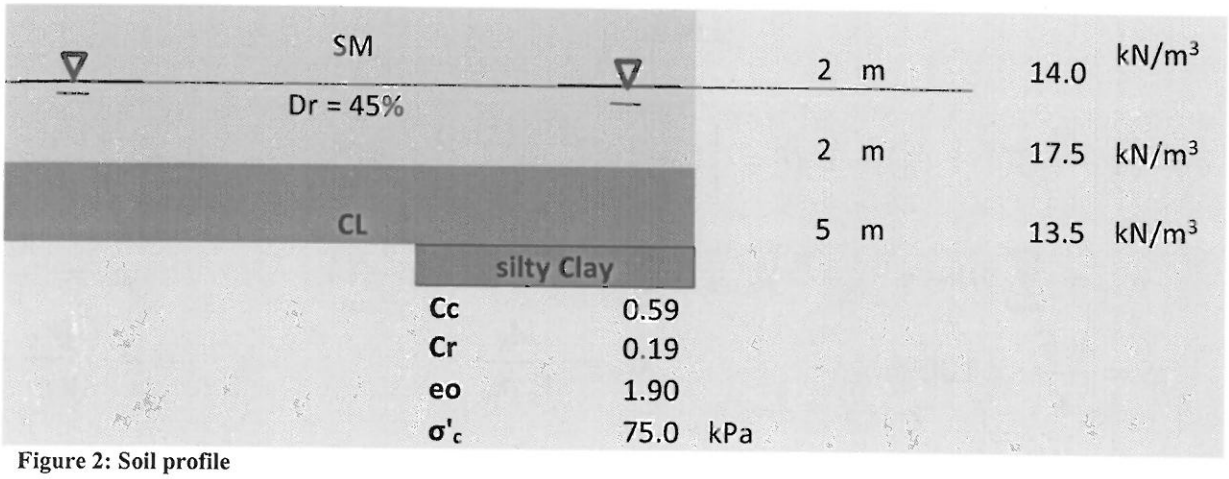

Figure 2: Soil profile

QUESTION 4 (20 MARKS)

4.1) Discuss the method of determining cv of a soil, and highlight some of the difficulties associated in its estimation. (5)

4.2) Discuss the soil mechanics applications of t_{90}

4.3) Table 1 shows results of a consolidation test on a normally consolidated undisturbed MH soil with a liquid limit of 65. The sample was 62mm in diameter 25mm tall and tested under a double drainage condition. Compute cv using the square root of time method (15)

Table 1: Consolidation data

Time since Loading (HH:MM:SS)	Dial Reading (mm)
00:01:01	7.21
00:03:16	7.74
00:08:35	8.40
00:16:39	9.01
00:30:15	9.60
00:59:17	10:11
01:54:29	10:35
04:02:30	10:45
08:20:00	10:52

QUESTION 5 (20 MARKS)

5.1) Discuss the limitations and merits of the direct shear test (10)

5.2) A certain soil has c' = 12kPa and ϕ' = 32°. The major and minor total principal stresses at a point in this soil are 348 and 160 kPa, respectively, and the pore water pressure

4/...

at this point is 96 kPa. Draw the Mohr circle and failure envelope and determine whether shear failure will occur at this point in the soil. If so, determine the angle between the failure plane and the plane on which the major principal stress acts. (10)

YOU MAY USE ANY OF THE FOLLOWING EQUATIONS AND TABLES

$$e = (1 - \varepsilon_z)(1 + e_0) - 1 \qquad U = \left[1 - 10^{-\left(\frac{0.085 + T_v}{0.933}\right)}\right] x100\% \qquad U = \sqrt{\frac{4T_v}{\pi}} x100\%$$

$$\sigma'_{zo} = \sum \gamma H - u \qquad \delta_{c,ult} = \sum \left(\frac{Cc}{1 + e_0}\right) H \log\left(\frac{\sigma'_{zf}}{\sigma'_{zo}}\right) \qquad \rho_d = \frac{M_s}{V}$$

$$S = \frac{wG_s}{e} x\ 100\% \qquad G_s = \frac{M_s}{V_s \rho_w} \qquad e = \frac{G_s \gamma_w}{\gamma_d} - 1$$

$$\gamma_d =$$

$$\sigma'_m = \sigma'_c - \sigma'_{z0} \qquad OCR = \frac{\sigma'_c}{\sigma'_{z0}}$$

$$\gamma_{sat} = \frac{G_s + e}{1 + e}\gamma_w \qquad \delta_{c,ult} = \sum \left(\frac{Cr}{1 + e_0}\right) H \log\left(\frac{\sigma'_{zf}}{\sigma'_c}\right) + \left(\frac{Cc}{1 + e_0}\right) H \log\left(\frac{\sigma'_c}{\sigma'_{zo}}\right)$$

$$T_v = \frac{c_v t}{H_{dr}^2}$$

$$\frac{u_e}{\Delta\sigma_z} = \sum_{N=0}^{\infty} \left(\frac{4}{(2N+1)\pi} sin\left[\frac{(2N+1)\pi}{2}\left(\frac{z_{dr}}{H_{dr}}\right)\right] e^{-\left[\frac{(2N+1)^2\pi^2}{4} T_v\right]}\right)$$

$$\Delta\sigma_z = q(A' + B') \tag{10.26}$$

where A' and B' are functions of z/R and r/R. (See Tables 10.6 and 10.7.)

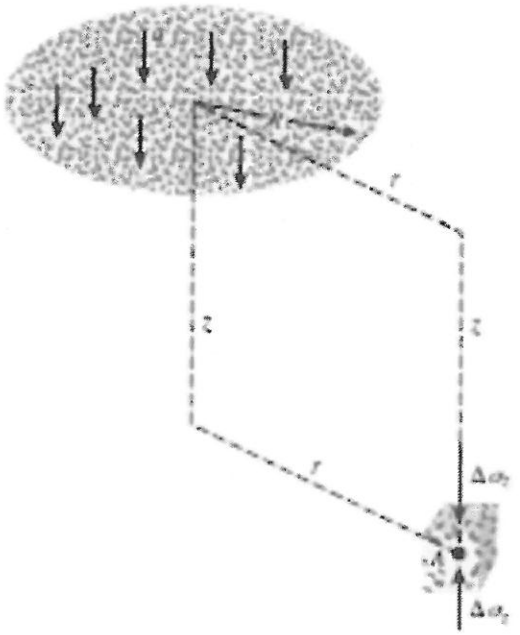

Figure 10.19 Vertical stress at any point below a uniformly loaded circular area

Table 10.6 Variation of A' with z/R and r/R*

z/R	r/R = 0	0.2	0.4	0.6	0.8	1	1.2	1.5	2
0	1.0	1.0	1.0	1.0	1.0	0.5	0	0	0
0.1	0.90050	0.89748	0.88679	0.86126	0.78797	0.43015	0.09645	0.02787	0.00856
0.2	0.80388	0.79824	0.77884	0.73483	0.63014	0.38269	0.15433	0.05251	0.01680
0.3	0.71265	0.70518	0.68316	0.62690	0.52081	0.34375	0.17964	0.07199	0.02440
0.4	0.62861	0.62015	0.59241	0.53767	0.44329	0.31048	0.18709	0.08593	0.03118
0.5	0.55279	0.54403	0.51622	0.46448	0.38390	0.28156	0.18556	0.09499	0.03701
0.6	0.48550	0.47691	0.45078	0.40427	0.33676	0.25588	0.17952	0.10010	
0.7	0.42654	0.41874	0.39491	0.35428	0.29833	0.21727	0.17124	0.10228	0.04558
0.8	0.37531	0.36832	0.34729	0.31243	0.26581	0.21297	0.16206	0.10236	
0.9	0.33104	0.32492	0.30669	0.27707	0.23832	0.19488	0.15253	0.10094	
1	0.29289	0.28763	0.27005	0.24697	0.21468	0.17868	0.14329	0.09849	0.05185
1.2	0.23178	0.22795	0.21662	0.19890	0.17626	0.15101	0.12570	0.09192	0.05260
1.5	0.16795	0.16552	0.15877	0.14804	0.13436	0.11892	0.10296	0.08048	0.05116
2	0.10557	0.10453	0.10140	0.09647	0.09011	0.08269	0.07471	0.06275	0.04496
2.5	0.07152	0.07098	0.06947	0.06698	0.06373	0.05974	0.05555	0.04880	0.03787
3	0.05132	0.05101	0.05022	0.04886	0.04707	0.04487	0.04241	0.03839	0.03150
4	0.02986	0.02976	0.02907	0.02802	0.02832	0.02749	0.02651	0.02490	0.02193
5	0.01942	0.01938				0.01835			0.01573
6	0.01361					0.01307			0.01168
7	0.01005					0.00976			0.00894
8	0.00772					0.00755			0.00703
9	0.00612					0.00600			0.00566
10								0.00477	0.00465

*Source: From Ahlvin, R. G., and H. H. Ulery. Tabulated Values for Determining the Complete Pattern of Stresses, Strains, and Deflections Beneath a Uniform Circular Load on a Homogeneous Half Space. In Highway Research Bulletin 342, Highway Research Board, National Research Council, Washington, D.C., 1962, Tables 1 and 2, p. 3. Reproduced with permission of the Transportation Research Board.

Table 10.7 Variation of B' with z/R and r/R*

z/R	r/R = 0	0.2	0.4	0.6	0.8	1	1.2	1.5	2
0	0	0	0	0	0	0	0	0	0
0.1	0.09852	0.10140	0.11138	0.13424	0.18796	0.05388	−0.07899	−0.02672	−0.00845
0.2	0.18857	0.19306	0.20772	0.23524	0.25983	0.08513	−0.07759	−0.04448	−0.01593
0.3	0.26362	0.26787	0.28018	0.29483	0.27257	0.10757	−0.04316	−0.04999	−0.02166
0.4	0.32016	0.32259	0.32748	0.32273	0.26925	0.12404	−0.00766	−0.04535	−0.02522
0.5	0.35777	0.35752	0.35323	0.33106	0.26236	0.13591	0.02165	−0.03455	−0.02651
0.6	0.37831	0.37531	0.36308	0.32822	0.25411	0.14440	0.04457	−0.02101	
0.7	0.38487	0.37962	0.36072	0.31929	0.24638	0.14986	0.06209	−0.00702	−0.02329
0.8	0.38091	0.37408	0.35133	0.30699	0.23779	0.15292	0.07530	0.00614	
0.9	0.36962	0.36275	0.33734	0.29299	0.22891	0.15404	0.08507	0.01795	
1	0.35355	0.34553	0.32075	0.27819	0.21978	0.15355	0.09210	0.02814	−0.01005
1.2	0.31485	0.30730	0.28481	0.24836	0.20113	0.14915	0.10002	0.04378	0.00023
1.5	0.25602	0.25025	0.23338	0.20694	0.17368	0.13732	0.10193	0.05745	0.01385
2	0.17889	0.18144	0.16644	0.15198	0.13375	0.11331	0.09234	0.06371	0.02836
2.5	0.12807	0.12633	0.12126	0.11327	0.10298	0.09130	0.07869	0.06022	0.03429
3	0.09487	0.09394	0.09099	0.08635	0.08033	0.07325	0.06551	0.05354	0.03511
4	0.05707	0.05666	0.05562	0.05383	0.05145	0.04773	0.04532	0.03995	0.03066
5	0.03772	0.03760				0.03384			0.02474
6	0.02666					0.02468			0.01968
7	0.01980					0.01868			0.01577
8	0.01526					0.01459			0.01279
9	0.01212					0.01170			0.01054
10								0.00924	0.00879

Table 10.6 (continued)

3	4	5	6	7	8	10	12	14
0	0	0	0	0	0	0	0	0
0.00211	0.00084	0.00042						
0.00419	0.00167	0.00083	0.00048	0.00030	0.00020			
0.00622	0.00250							
0.01013	0.00407	0.00209	0.00118	0.00071	0.00053	0.00025	0.00014	0.00009
0.01742	0.00761	0.00393	0.00226	0.00143	0.00097	0.00050	0.00029	0.00018
0.01935	0.00871	0.00459	0.00269	0.00171	0.00115			
0.02142	0.01013	0.00548	0.00325	0.00210	0.00141	0.00073	0.00043	0.00027
0.02221	0.01160	0.00659	0.00399	0.00264	0.00180	0.00094	0.00056	0.00036
0.02143	0.01221	0.00732	0.00463	0.00308	0.00214	0.00115	0.00068	0.00043
0.01980	0.01220	0.00770	0.00505	0.00346	0.00242	0.00132	0.00079	0.00051
0.01592	0.01109	0.00768	0.00536	0.00384	0.00282	0.00160	0.00099	0.00065
0.01249	0.00949	0.00708	0.00527	0.00394	0.00298	0.00179	0.00113	0.00075
0.00983	0.00795	0.00628	0.00492	0.00384	0.00299	0.00188	0.00124	0.00084
0.00784	0.00661	0.00548	0.00445	0.00360	0.00291	0.00193	0.00130	0.00091
0.00635	0.00554	0.00472	0.00398	0.00332	0.00276	0.00189	0.00134	0.00094
0.00520	0.00466	0.00409	0.00353	0.00301	0.00256	0.00184	0.00133	0.00096
0.00438	0.00397	0.00352	0.00326	0.00273	0.00241			

Table 10.7 (continued)

3	4	5	6	7	8	10	12	14
0	0	0	0	0	0	0	0	0
−0.00210	−0.00084	−0.00042						
−0.00412	−0.00166	−0.00083	−0.00024	−0.00015	−0.00010			
−0.00599	−0.00245							
−0.00991	−0.00388	−0.00199	−0.00116	−0.00073	−0.00049	−0.00025	−0.00014	−0.00009
−0.01115	−0.00608	−0.00344	−0.00210	−0.00135	−0.00092	−0.00048	−0.00028	−0.00018
−0.00995	−0.00632	−0.00378	−0.00236	−0.00156	−0.00107			
−0.00669	−0.00600	−0.00401	−0.00265	−0.00181	−0.00126	−0.00068	−0.00040	−0.00026
0.00028	−0.00410	−0.00371	−0.00278	−0.00202	−0.00148	−0.00084	−0.00050	−0.00033
0.00661	−0.00130	−0.00271	−0.00250	−0.00201	−0.00156	−0.00094	−0.00059	−0.00039
0.01112	0.00157	−0.00134	−0.00192	−0.00179	−0.00151	−0.00099	−0.00065	−0.00046
0.01515	0.00595	0.00155	−0.00029	−0.00094	−0.00109	−0.00094	−0.00068	−0.00050
0.01522	0.00810	0.00371	0.00132	0.00013	−0.00043	−0.00070	−0.00061	−0.00049
0.01380	0.00867	0.00496	0.00254	0.00110	0.00028	−0.00037	−0.00047	−0.00045
0.01204	0.00842	0.00547	0.00332	0.00185	0.00093	−0.00002	−0.00029	−0.00037
0.01034	0.00779	0.00554	0.00372	0.00236	0.00141	0.00035	−0.00008	−0.00025
0.00888	0.00705	0.00533	0.00386	0.00265	0.00178	0.00066	0.00012	−0.00012
0.00764	0.00631	0.00501	0.00382	0.00281	0.00199			