UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2016/2017 Academic Session

June 2017

EAG442 – Advanced Geotechnical Engineering
[Kejuruteraan Geoteknik Lanjutan]

Duration : 3 hours
[Masa : 3 jam]

Please check that this examination paper consists of **SEVENTEEN (17)** pages of printed material before you begin the examination.
*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **TUJUH BELAS (17)** muka surat yang bercetak sebelum anda memulakan peperiksaan ini.*]

Instructions : This paper consists of **SIX (6)** questions. Answer **FIVE (5)** questions.
*[**Arahan** : Kertas ini mengandungi **ENAM (6)** soalan. Jawab **LIMA (5)** soalan.]*

You may answer the question either in Bahasa Malaysia or English.
[Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]

All questions **MUST BE** answered on a new page.
*[Semua soalan **MESTILAH** dijawab pada muka surat baru.]*

In the event of any discrepancies, the English version shall be used.
[Sekiranya terdapat percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.]

1. The profile of **Figure 1** shows a strip foundation positioned on ground surface overlying a compressible clay stratum. The water level is at ground surface, as shown.

*Profil di **Rajah 1** menunjukkan suatu tapak jalur yang terletak di permukaan tanah manakala di bawahnya terdapat lapisan tanah liat boleh mampat. Paras air di permukaan tanah, seperti diberi.*

[a] Determine the eventual vertical effective stresses at positions 1, 2, and 3 which are respectively 2.0 m, 4.0 m, and 6.0 m below the center of the foundation strip. The chart of **Figure 2** may be used for your calculations.

*Tentukan tekanan efektif tegak yang akhirnya terjadi pada kedudukan 1, 2, dan 3 iaitu pada paras 2.0 m, 4.0 m, dan 6.0 m di bawah tengah jalur tapak. Carta di **Rajah 2** boleh digunakan dalam pengiraan anda.*

[5 marks/*markah*]

[b] Determine the total consolidation settlement due to the foundation loading as stated in **Figure 1**. The clay layer may be divided into 3 sub-layers of equal thicknesses. The relevant compression curve for the clay is given in **Figure 3**.

*Tentukan jumlah enapan pengukuhan yang disebabkan oleh beban tapak seperti diberi di **Rajah 1**. Lapisan tanah liat boleh dibahagi kepada tiga sub-lapisan dengan ketebalan yang sama. Lengkung mampatan bagi tanah liat tersebut diberi di **Rajah 3**.*

[5 marks/*markah*]

[c] In order to eliminate the consolidation settlement, it is now desirable to treat the site using pre-fabricated vertical drains (PVD) together with a preloading. By assuming an equivalent PVD diameter of 10 cm and PVD spacing of 1.5 m, determine the treatment time required to achieve 100% consolidation of the site. The preloading available for use is a 3 m uniform fill with a unit weight of 20 kN/m^3. The consolidation curve relevant to the problem is given in **Figure 4**.

Appendix 1 and **2** of the attachment are respectively the vertical and radial time factors for the corresponding degrees of consolidation.

Bagi menghindari enapan pengukuhan tersebut keseluruhannya, kawasan tapak ini akan dirawat menggunakan kaedah saliran tegak (PVD) bersama dengan pra-beban. Dengan menganggap garispusat PVD 10cm dan jarak antara PVD 1.5 m, tentukan masa rawatan diperlukan bagi mendapatkan 100% pengukuhan kawasan. Prabebanan seragam yang mampu digunakan 3 m tebal dengan berat unitnya 20 kN/m^3. Lengkung pengukuhan yang berkaitan dengan soalan ini diberi di ***Rajah 4****. **Appendiks 1** di lampiran memberi nilai faktor masa bagi saliran tegak manakala **Appendiks 2** di lampiran memberi nilai faktor masa bagi saliran radial, bagi darjah pengukuhan yang berkaitan.*

[10 marks/*markah*]

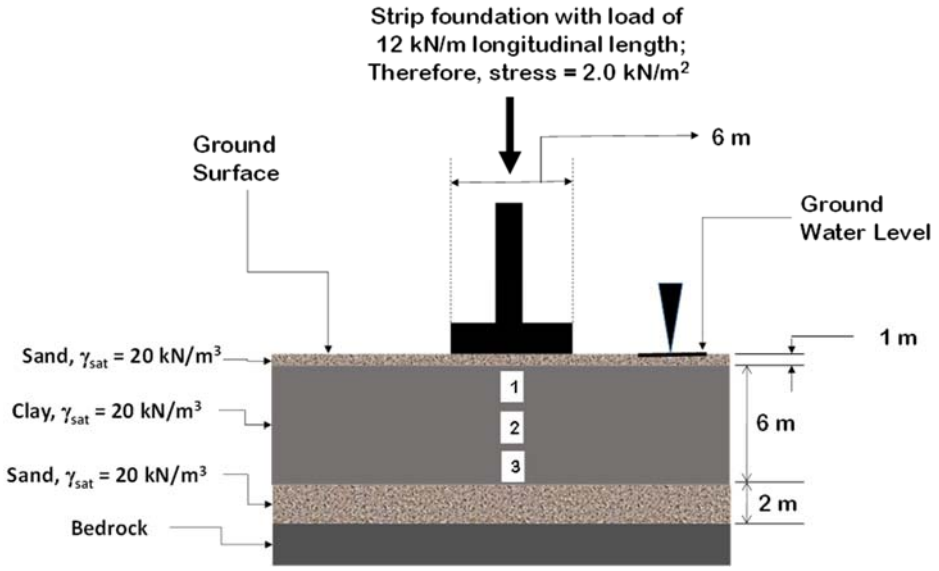

Figure 1 / *Rajah 1*

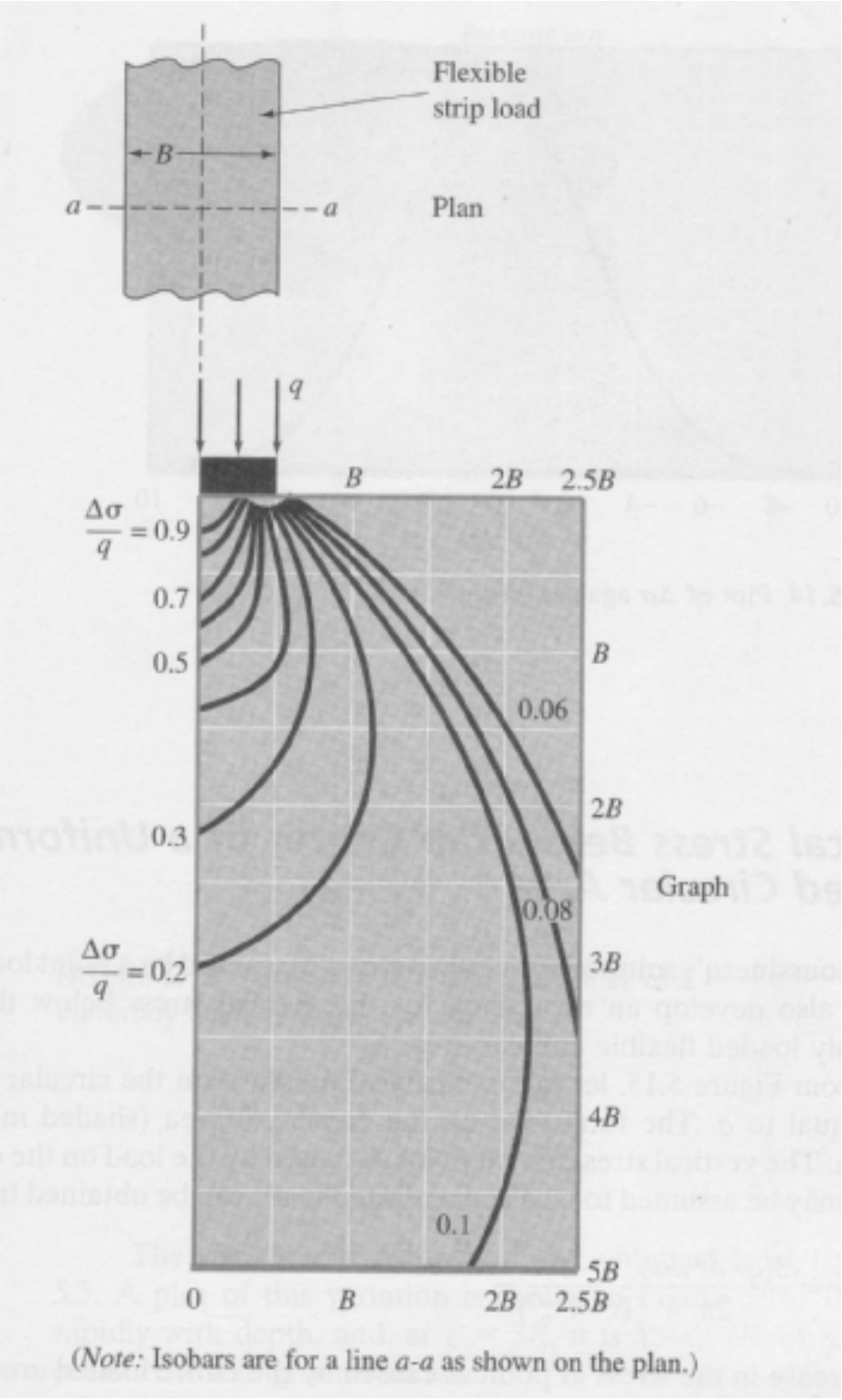

Figure 2 – Vertical pressure isobars under flexible strip loading

Rajah 2 - Garisan-garisan setekanan menegak di bawah beban jalur

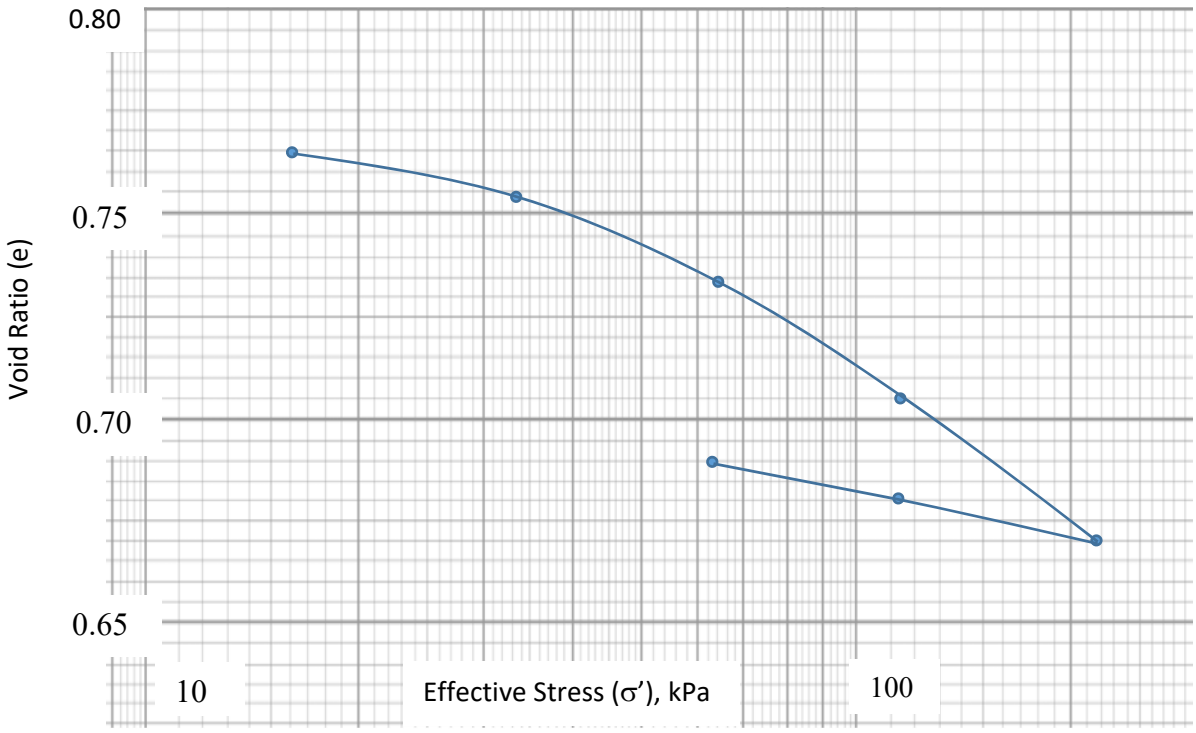

Figure 3 – Compression curve

Rajah 3 - Lengkung mampatan

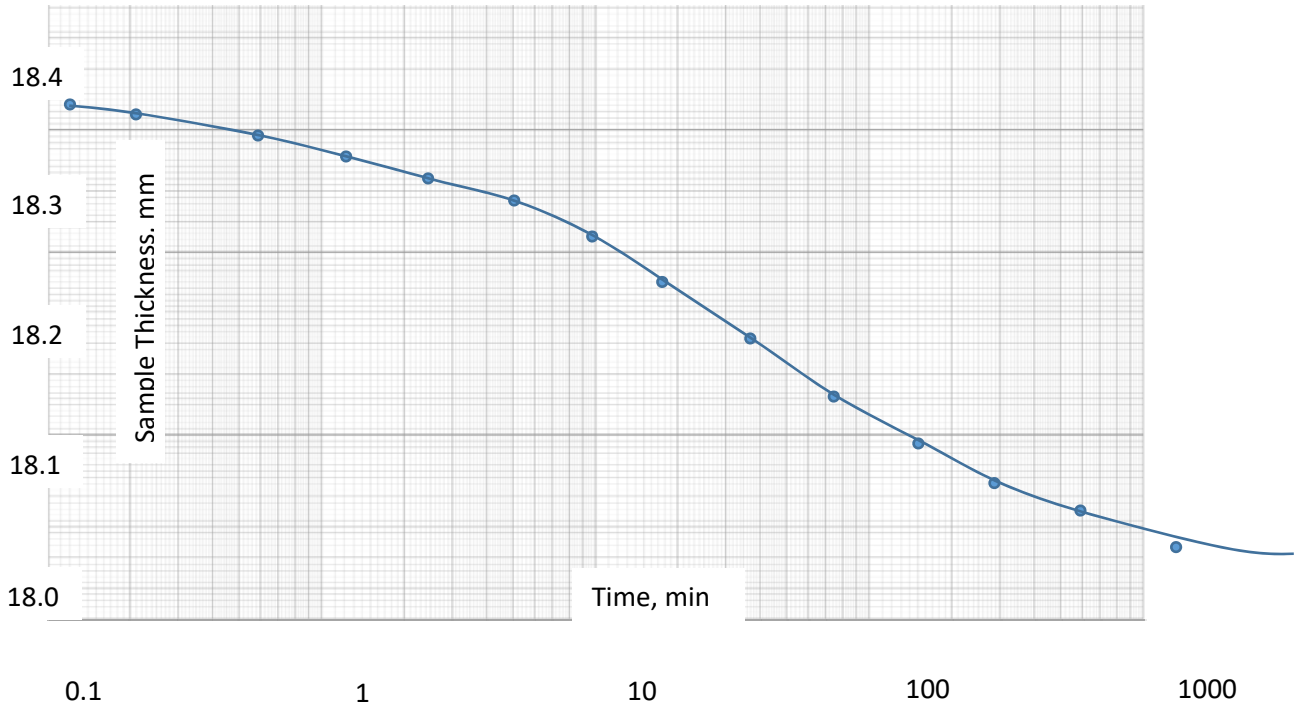

Figure 4 – Consolidation curve

Rajah 4 - Lengkung pengukuhan

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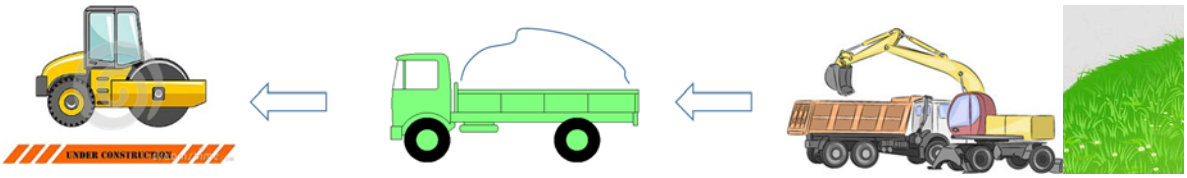
2. The relative compaction required of a fill site is 95% of the maximum dry unit weight as determined by the Modified Proctor Method. The maximum dry unit weight, γ_{dmax} , was determined to be 20 kN/m^3 and the minimum void ratio, e_{min} , is defined as the void ratio at the given maximum dry unit weight. The relative density, $\frac{e_{max}-e}{e_{max}-e_{min}}$, of soil while being transported was determined to be 21%. At the borrow site, the dry unit weight was determined to be 12 kN/m^3. Furthermore, the maximum void ratio of the soil was determined to be 2.8, while G_s is 2.6. The above information is summarized in **Figure 5**.

*Mampatan relatif bagi suatu tapak 95% daripada berat unit kering maksimum, menurut kaedah Proctor Terubahsuai. Berat unit maksimum, γ_{dmax} , telah ditentukan sebagai 20 kN/m^3 manakala nisbah lompang minimum, e_{min} , dimaksudkan sebagai nisbah lompang pada berat unit kering maksimum seperti diberi. Nilai ketumpatan relative, $\frac{e_{max}-e}{e_{max}-e_{min}}$, bagi tanah sewaktu diangkut 21%. Ditempat korekan, berat unit kering telah ditentukan sebagai 12 kN/m^3. Nisbah lompang maksimum telah ditentukan sebagai 2.8, manakala G_s 2.6. Maklumat diatas diberi di **Rajah 5**.*



At fill site :/ *Ditapak pengisian :*	During transport :/ *Sewaktu diangkut :*	At borrow site:/ *Ditempat korekan :*
γ_d=0.95$\gamma_{d(max)}$=19 kN/m^3	$\frac{e_{max}-e}{e_{max}-e_{min}}$ = 21%	Volume / *Isipadu* =1,000,000 m^3
Volume / *Isipadu* =?	Volume / *Isipadu* =?	γ_d=12 kN/m^3
e =?	w= 20%	e_{max} = 2.8
	Weight / *Berat* =?	$\gamma_{d(max)}$=20 kN/m^3
	e =?	

Figure 5 / *Rajah 5*

[a] If the available borrow volume is 1,000,000 m^3, determine the resulting compacted volume at fill site if all of the borrow soil is used.

Jika isipadu korekan 1,000,000 m^3, tentukan isipadu terpadat di tapak pengisian jika keseluruhan tanah korekan digunakan.

[10 marks/*markah*]

[b] Determine the void ratios of soil material at borrow site, while being transported, and when compacted at the fill site.

Tentukan nisbah lompang bagi tanah ditapak pengorekan, sewaktu diangkut, dan apabila sudah dipadatkan di tempat pengisian.

[5 marks/*markah*]

[c] Determine the total volume of soil material while being transported and its total weight if the moisture content is 20%.

Tentukan jumlah isipadu tanah sewaktu diangkut dan berat keseluruhannya jika kandungan airnya 20%.

[5 marks/*markah*]

3. [a] Explain the main purpose when designing using geosynthetics of any improvement techniques in the market? Describe briefly the details according to its theories and practices.

Terangkan tujuan utama apabila merekabentuk dengan penggunaan geosintetik atau teknik pembaikan yang ada di pasaran? Huraikan secara ringkas mengikut teori dan praktis.

[5 marks/*markah*]

[b] Give **FOUR (4)** different types of geosynthethics and prescribe them with sketches their roles and functions of geotechnical engineering applications.

*Berikan **EMPAT (4)** perbezaan jenis geosintetik dan perincikan dengan lakaran peranan dan fungsi dalam aplikasi kejuruteraan geoteknik.*

[5 marks/*markah*]

[c] Design a 5 m high reinforced wall as shown in **Figure 6** where the reinforcement spacing is limited to 1 m since the wall facing is of precast segmented concrete facing panel type. The coverage ratio is Cr = 0.8. The length-to-height ratio of the reinforced soil wall should not be less than 0.7. Calculate factor of safety against sliding, overturning, stresses on foundation and vertical spacing. Additional details of the problem given:

*Rekabentuk 5 m tembok geogrid-bertetulang sepert di tunjukkan di **Rajah 6**, dengan jarak tetulang di hadkan sehingga 1 m memandangkan muka tembok adalah dari jenis panel konkrit pasang siap yang bersegmen. Nisbah penutup adalah C_r = 0.8. Nisbah panjang-ketinggian untuk tembok tanah bertetulang tidak kurang dari 0.7. Kira faktor keselamatan terhadap gelinciran, terbalikan, tegesan keatas asas dan jarak menegak. Perincian tambahan diberi seperti di bawah:*

Reinforcement data:
Data Tetulang:

T_{ult} = 170 kN/ m^2

FS_p = 4.17

T_{allow} = 40 kN/m^2

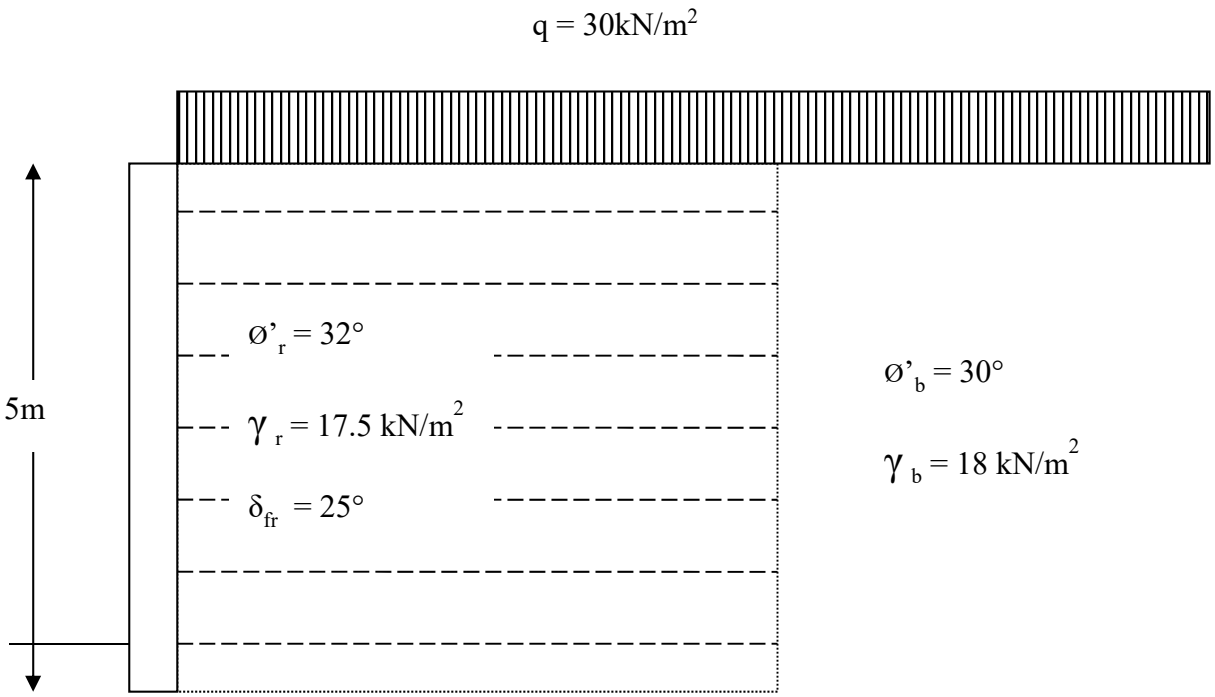
FS_g = 1.2

T_{des} = 25 kN/m^2

Equations given for calculation purposes:

Persamaan diberi untuk tujuan pengiraan:

$K = \tan 2 (45 - \emptyset b / 2)$, $F = W\mu$, SV $\sigma_n / C_r = T_{des}$, $L = L_e + L_R$



Bearing Capacity = 150 kN/ m^2

Figure 6/ *Rajah 6*

[10 marks/*markah*]

4. [a] Why and how landslide occurs? Describe the terms and factors contributing to the failure.

Kenapa dan bagaimana tanah runtuh terjadi? Terangkan definisi dan faktor-faktor penyebab kegagalan tersebut.

[8 marks/*markah*]

[b] Give **FOUR (4)** types of landslide movement that can be classified as soil and rock movement. Sketch each of the movements and describes the reason.

*Beri **EMPAT (4)** jenis pergerakan tanah runtuh yang di klasifikasi untuk pergerakan tanah dan batuan. Berikan lakaran pergerakan dan terangkan penyebab.*

[6 marks/*markah*]

[c] In order to conduct the soil investigation at the landslide site, what are the criteria and specifications required?

Bagi tujuan menjalankan penyiasatan tanah di tapak tanah runtuh, apakah kriteria dan spesikasi yang di perlukan?

[6 marks/*markah*]

5. [a] Geological structures such as faults, fractures, and discontinuities determine the overall rock mass strength, deformability and hydraulic properties of the rock mass. The existence of the geological structures makes the rock mass heterogeneous and anisotropic and thus very difficult to evaluate the mechanical and hydraulic behavior of the rock mass in the context of engineering works. With the help of sketches, explain **TWO (2)** main characteristics and geometric parameters of the rock mass and how these parameters will affect the engineering project or structure interact with it.

Struktur-struktur geologi seperti sesar, retakan dan ketakselanjaran menentukan kekuatan, ketercacatbentukan dan sifat-sifat hidraulik batuan. Kewujudan struktur-struktur geologi ini menjadikan batuan beragam dan tak isotropi, dan menyebabkan sukar untuk menilai kelakuan mekanik dan hidraulik batuan dalam konteks kerja-kerja kejuruteraan. Jelaskan ***DUA (2)*** *ciri-ciri utama dan parameter geometri batuan dan bagaimana parameter tersebut akan memberi kesan kepada projek atau struktur kejuruteraan yang berinteraksi denganya.*

[10 marks/*markah*]

[b] A circular tunnel with 10 m diameter will be excavated using tunnel boring machine at East Coast Rail Line Project under the overburden depth of 1000 m. Based on preliminary site investigation results, the uniaxial compressive strength of the rock mass is estimated to be around 90 MPa and the tensile strength is 7 MPa. The typical unit weight of the granitic rock is 26 KN/m^3 and the K_o obtained from the similar tunneling project is 0.37. In order to assess the associated risk for tunneling works under the high overburden:

Terowong berbentuk bulat dengan diameter 10 m akan dikorek dengan menggunakan mesin korek terowong di Projek Landasan Keretapi Pantai Timur dibawah kedalaman tanggungan atas, 1000 m. Berdasarkan kepada keputusan awal penyiasatan tapak, kekuatan mampatan ekapaksi batuan dianggarkan sekitar 90 MPa dan kekuatan tegangan, 7 MPa. Berat unit tipikal batuan granit, 26 KN/m^3 dan K_o yang diperolehi daripada projek terowong yang hampir sama, 0.37. Untuk menilai risiko yang berkaitan dengan kerja-kerja terowongan dibawah kedalaman tanggungan yang tinggi:

[i] Determine the induced stress at the tunnel crown and sidewalls using the Kirsch equation.

Tentukan tegasan teraruh pada puncak dan dinding tepi terowong dengan menggunakan persamaan Kirsch.

[6 marks/*markah*]

[ii] Based on the criteria given in **Table 1**, evaluate whether there is any possibility of rock overstressing to occur along the high overburden tunnel section.

*Berdasarkan kepada kriteria yang diberikan di **Jadual 1**, nilaikan samaada wujud kemungkinan berlakunya redakan batuan disepanjang keratan terowong yang mempuyai kedalaman tanggungan yang tinggi.*

[4 marks/*markah*]

Table 1/*Jadual 1*

Rock stress/ *Tegasan Batuan*	σ_c/σ_1
Low stress near surface/ *Tegasan rendah dekat permukaan*	>200
Medium stress/*Tegasan sederhana*	200-10
High stress/*Tegasan tinggi*	10-5
Mild rockburst/*Redakan batuan ringan*	5-2.5
Heavy rockburst/*Redakan batuan berat*	<2.5

6. [a] Geological structures such as folds, faults, and discontinuities play a critical role in the stability and behaviour of both natural and engineered rock slopes. The pattern of the discontinuities may be comprised of a single discontinuity, or a pair of discontinuities that intersect each other, or a combination of multiple discontinuities that are linked together to form a failure mode. With the help of sketches, describe **TWO (2)** types of failure that are common for rock slope.

*Struktur-struktur geologi seperti lipatan, sesar dan ketakselanjaran memainkan peranan penting di dalam kestabilan dan kelakuan kedua-dua cerun batuan semulajadi dan tereka bentuk. Pola ketakselanjaran mungkin meliputi ketakselanjaran tunggal, atau sepasang ketakselanjaran yang bersilang antara satu sama lain, atau kombinasi ketakselanjaran berbilang yang berhubung bagi membentuk mod kegagalan. Dengan berbantukan lakaran, terangkan **DUA (2)** jenis kegagalan yang biasa berlaku bagi cerun batuan.*

[8 marks/*markah*]

[b] A section of rock slope for the road works of rolled earth dam construction in Hulu Terengganu has been identified to be unstable from the monitoring data. Detailed investigation at site has found that two (2) critical discontinuities with orientation of 46º, 106º and 71º, 236º exist on the slope. The slope face has an orientation of 66º, 186º and upper slope surface, 13º, 196º.

Keratan cerun batuan bagi kerja-kerja jalan untuk pembinaan empangan tanah tergelek di Hulu Terengganu didapati berada di dalam keadaan tidak stabil melalui data pemantauan. Penyiasatan terperinci di tapak mendapati wujud dua (2) ketidakselanjaran kritikal dengan orientasi 46º, 106º dan 71º, 236º pada cerun tersebut. Permukaan cerun mempunyai orientasi 65º, 185º dan permukaan atas cerun, 13º, 196º.

[i] Using stereonet, plot the great circles representing the four (4) planes.

Dengan menggunakan stereonet, plotkan bulatan besar yang mewakili empat (4) satah tersebut.

[6 marks/*markah*]

[ii] Identify the critical intersection of the discontinuities for the rock slope.

Kenal pasti persilangan kritikal ketidakselanjaran untuk cerun batuan tersebut.

[2 marks/*markah*]

[iii] From the critical intersection identified, evaluate whether the discontinuities may kinematically form a wedge failure and suggest a suitable engineering countermeasure that can be used to minimize the risk of the slope failure.

Daripada persilangan kritikal yang dikenal pasti, nilaikan samaada ketidakselanjaran tersebut akan secara kinematik membentuk kegagalan baji dan cadangkan rawatan kejuruteraan yang bersesuaian yang dapat digunakan untuk meminimumkan risiko kegagalan cerun tersebut.

[4 marks/*markah*]

APPENDIX/*LAMPIRAN*

Appendix 1

U (%)	T_v	U (%)	T_v	U (%)	T_v
0	0	34	0.0907	68	0.377
1	0.00008	35	0.0962	69	0.390
2	0.0003	36	0.102	70	0.403
3	0.00071	37	0.107	71	0.417
4	0.00126	38	0.113	72	0.431
5	0.00196	39	0.119	73	0.446
6	0.00283	40	0.126	74	0.461
7	0.00385	41	0.132	75	0.477
8	0.00502	42	0.138	76	0.493
9	0.00636	43	0.145	77	0.511
10	0.00785	44	0.152	78	0.529
11	0.0095	45	0.159	79	0.547
12	0.0113	46	0.166	80	0.567
13	0.0133	47	0.173	81	0.588
14	0.0154	48	0.181	82	0.610
15	0.0177	49	0.188	83	0.633
16	0.0201	50	0.197	84	0.658
17	0.0227	51	0.204	85	0.684
18	0.0254	52	0.212	86	0.712
19	0.0283	53	0.221	87	0.742
20	0.0314	54	0.230	88	0.774
21	0.0346	55	0.239	89	0.809
22	0.0380	56	0.248	90	0.848
23	0.0415	57	0.257	91	0.891
24	0.0452	58	0.267	92	0.938
25	0.0491	59	0.276	93	0.993
26	0.0531	60	0.286	94	1.055
27	0.0572	61	0.297	95	1.129
28	0.0615	62	0.307	96	1.219
29	0.0660	63	0.318	97	1.336
30	0.0707	64	0.329	98	1.500
31	0.0754	65	0.304	99	1.781
32	0.0803	66	0.352	100	∞
33	0.0855	67	0.364		

…16-

Appendix 2

Degree of consolidation, U_r (%)	Time factor, T_r, for values of n				
	5	10	15	20	25
0	0	0	0	0	0
1	0.0012	0.0020	0.0025	0.0028	0.0031
2	0.0024	0.0040	0.0050	0.0057	0.0063
3	0.0036	0.0060	0.0075	0.0086	0.0094
4	0.0048	0.0081	0.0101	0.0115	0.0126
5	0.0060	0.0101	0.0126	0.0145	0.0159
6	0.0072	0.0122	0.0153	0.0174	0.0191
7	0.0085	0.0143	0.0179	0.0205	0.0225
8	0.0098	0.0165	0.0206	0.0235	0.0258
9	0.0110	0.0186	0.0232	0.0266	0.0292
10	0.0123	0.0208	0.0260	0.0297	0.0326
11	0.0136	0.0230	0.0287	0.0328	0.0360
12	0.0150	0.0252	0.0315	0.0360	0.0395
13	0.0163	0.0275	0.0343	0.0392	0.0431
14	0.0177	0.0298	0.0372	0.0425	0.0467
15	0.0190	0.0321	0.0401	0.0458	0.0503
16	0.0204	0.0344	0.0430	0.0491	0.0539
17	0.0218	0.0368	0.0459	0.0525	0.0576
18	0.0232	0.0392	0.0489	0.0559	0.0614
19	0.0247	0.0416	0.0519	0.0594	0.0652
20	0.0261	0.0440	0.0550	0.0629	0.0690
21	0.0276	0.0465	0.0581	0.0664	0.0729
22	0.0291	0.0490	0.0612	0.0700	0.0769
23	0.0306	0.0516	0.0644	0.0736	0.0808
24	0.0321	0.0541	0.0676	0.0773	0.0849
25	0.0337	0.0568	0.0709	0.0811	0.0890
26	0.0353	0.0594	0.0742	0.0848	0.0931
27	0.0368	0.0621	0.0776	0.0887	0.0973
28	0.0385	0.0648	0.0810	0.0926	0.1016
29	0.0401	0.0676	0.0844	0.0965	0.1059
30	0.0418	0.0704	0.0879	0.1005	0.1103
31	0.0434	0.0732	0.0914	0.1045	0.1148
32	0.0452	0.0761	0.0950	0.1087	0.1193
33	0.0469	0.0790	0.0987	0.1128	0.1239
34	0.0486	0.0820	0.1024	0.1171	0.1285
35	0.0504	0.0850	0.1062	0.1214	0.1332
36	0.0522	0.0881	0.1100	0.1257	0.1380
37	0.0541	0.0912	0.1139	0.1302	0.1429
38	0.0560	0.0943	0.1178	0.1347	0.1479
39	0.0579	0.0975	0.1218	0.1393	0.1529
40	0.0598	0.1008	0.1259	0.1439	0.1580
41	0.0618	0.1041	0.1300	0.1487	0.1632
42	0.0638	0.1075	0.1342	0.1535	0.1685
43	0.0658	0.1109	0.1385	0.1584	0.1739
44	0.0679	0.1144	0.1429	0.1634	0.1793
45	0.0700	0.1180	0.1473	0.1684	0.1849
46	0.0721	0.1216	0.1518	0.1736	0.1906
47	0.0743	0.1253	0.1564	0.1789	0.1964
48	0.0766	0.1290	0.1611	0.1842	0.2023
49	0.0788	0.1329	0.1659	0.1897	0.2083
50	0.0811	0.1368	0.1708	0.1953	0.2144

…17-

Appendix 2

Degree of consolidation, U_r (%)	Time factor, T_r, for values of n				
	5	10	15	20	25
51	0.0835	0.1407	0.1758	0.2020	0.2206
52	0.0859	0.1448	0.1809	0.2068	0.2270
53	0.0884	0.1490	0.1860	0.2127	0.2335
54	0.0909	0.1532	0.1913	0.2188	0.2402
55	0.0935	0.1575	0.1968	0.2250	0.2470
56	0.0961	0.1620	0.2023	0.2313	0.2539
57	0.0988	0.1665	0.2080	0.2378	0.2610
58	0.1016	0.1712	0.2138	0.2444	0.2683
59	0.1044	0.1759	0.2197	0.2512	0.2758
60	0.1073	0.1808	0.2258	0.2582	0.2834
61	0.1102	0.1858	0.2320	0.2653	0.2912
62	0.1133	0.1909	0.2384	0.2726	0.2993
63	0.1164	0.1962	0.2450	0.2801	0.3075
64	0.1196	0.2016	0.2517	0.2878	0.3160
65	0.1229	0.2071	0.2587	0.2958	0.3247
66	0.1263	0.2128	0.2658	0.3039	0.3337
67	0.1298	0.2187	0.2732	0.3124	0.3429
68	0.1334	0.2248	0.2808	0.3210	0.3524
69	0.1371	0.2311	0.2886	0.3300	0.3623
70	0.1409	0.2375	0.2967	0.3392	0.3724
71	0.1449	0.2442	0.3050	0.3488	0.3829
72	0.1490	0.2512	0.3134	0.3586	0.3937
73	0.1533	0.2583	0.3226	0.3689	0.4050
74	0.1577	0.2658	0.3319	0.3795	0.4167
75	0.1623	0.2735	0.3416	0.3906	0.4288
76	0.1671	0.2816	0.3517	0.4021	0.4414
77	0.1720	0.2900	0.3621	0.4141	0.4546
78	0.1773	0.2988	0.3731	0.4266	0.4683
79	0.1827	0.3079	0.3846	0.4397	0.4827
80	0.1884	0.3175	0.3966	0.4534	0.4978
81	0.1944	0.3277	0.4090	0.4679	0.5137
82	0.2007	0.3383	0.4225	0.4831	0.5304
83	0.2074	0.3496	0.4366	0.4922	0.5481
84	0.2146	0.3616	0.4516	0.5163	0.5668
85	0.2221	0.3743	0.4675	0.5345	0.5868
86	0.2302	0.3879	0.4845	0.5539	0.6081
87	0.2388	0.4025	0.5027	0.5748	0.6311
88	0.2482	0.4183	0.5225	0.5974	0.6558
89	0.2584	0.4355	0.5439	0.6219	0.6827
90	0.2696	0.4543	0.5674	0.6487	0.7122
91	0.2819	0.4751	0.5933	0.6784	0.7448
92	0.2957	0.4983	0.6224	0.7116	0.7812
93	0.3113	0.5247	0.6553	0.7492	0.8225
94	0.3293	0.5551	0.6932	0.7927	0.8702
95	0.3507	0.5910	0.7382	0.8440	0.9266
96	0.3768	0.6351	0.7932	0.9069	0.9956
97	0.4105	0.6918	0.8640	0.9879	1.0846
98	0.4580	0.7718	0.9640	1.1022	1.2100
99	0.5391	0.9086	1.1347	1.2974	1.4244

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