UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2011/2012

COURSE NAME	:	GEOSYNTHETIC DESIGN
COURSE CODE	:	BFG 4043
PROGRAMME	:	4 BFF
EXAMINATION DATE	:	JUNE 2012
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR(4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

Q1

(a) Discuss the significance of specifying the correct boundary conditions and choosing the appropriate type of elements in the finite element analysis software packages available for the design of reinforced earth structures.

(6 marks)

(b) List the pros and cons for the interaction of the advancement of Information Technology with geotechnical engineering, and in particular the use of geosynthetics.

(6 marks)

(c) "Soil reinforcement is often used to improve the properties of soil masses. Consequently there is a rapidly booming popularity to adopt geosynthetics in the construction industry".

Discuss this statement in general and also by making appropriate references to the group project you did during the semester.

(7 marks)

(d) Describe and comment on the **THREE(3)** different design approaches adopted in the design and application of geosynthetics.

(6 marks)

Q2

(a) With the aid of suitable diagrams and making relevant comments, define the notations in the following two equations which are used in design of reinforced earth walls and is also found in BS 8006 (1995)

(8 marks)

$$T_{Aj} = \frac{L_{ej}P_j}{f_p}\left[\frac{\alpha' \tan\phi'_p}{f_{ms}}\left(f_{ps}\gamma_s h_j + f_f w_s\right) + \frac{\alpha'_{bc}c'}{f_{ms}}\right] \quad \text{and}$$

$$T = K_a \gamma Z S_v S_h\left(1 + K_a \frac{Z^2}{L^2}\right)$$

(a) The finished height of a reinforced earth abutment is 8.5m and a wide uniformly distributed surcharge of 15 kN/m^2 needs to be carried on the surface of the abutment. The length of the metal strips used to reinforce the wall is 6 m. The cross section of the metal strips is rectangular and its dimensions are 50 mm x 3 mm. It is proposed to place them at a horizontal spacing of 1.2 m and a vertical spacing of 0.75 m. The highest and lowest metal strips lie at depths of 0.6 m and 7.1 m respectively below the top of the wall.

The properties of the metal strips are;

Interface friction angle	23°
Characteristic yield strength	275 N/mm^2

The geotechnical properties of the non cohesive coarse grained backfill are;

Unit weight	19.5 kN/m^3
Angle of friction	36°

The following partial factors of safety need to be considered in the design;

Partial factor of safety on the material	1.2
Partial load factor on the soil self weight	1.0
Partial load factor on surcharge	1.5
Partial load factor for pull out resistance	1.3

Investigate the stability of the internal reinforcement design and suggest if necessary appropriate modifications to achieve local stability.

(17 marks)

Q3

(a) "Geotextiles, as they are known today, were first used in connection with erosion control applications and were intended to be an alternative to granular soil filters".
Discuss the above statement making reference to the criteria for design of traditional granular soil filters and the convenience of the use of geotextiles instead.

(7 marks)

(b) The concept of permeability is significantly important when using geosynthetics.
Define and describe the differences between Permeability and absolute impermeability.

(6 marks)

(c) With the aid of suitable sketches, explain the differences between the terms filtration and drainage in the context of geotextile and their use in the design of geotextile around perforated pipe underdrains.

(6 marks)

(d) Describe how geotextiles are used to facilitate erosion control structures.

(6 marks)

Q4

(a) (i) Define the term "geosynthetic"

(ii) Describe and illustrate with suitably labeled diagrams major geotechnical function that geosynthetics serve.

(5 marks)

(b) (i) With the aid of suitable sketches, describe the different types of woven and nonwoven geotextiles.

(ii) Indicate a ranking of these geotextiles from a production point of view based on the equivalent mass per unit area and also on an effective geotechnical usefulness point of view.

(5 marks)

(c) 20 rolls of geotextiles were delivered to a site. The inspector sampled several of these rolls to find the minimum average roll value of the grab tensile strength. This quality control inspection was done to check whether the product met the requirement of 120 for Type B Erosion Control application. A full width piece, 1m long was taken from each of six randomly selected rolls and sent to an approved laboratory for testing. Given their laboratory test report in Table 1 below,

(i) Determine the minimum average and the standard deviation of the grab tensile strength measured .

(ii) Indicate your comments and the action you would take if you were this inspector.

Table 1: Laboratory Test Report

Test no.	Roll no.					
	1	2	3	4	5	6
1	140	127	135	142	150	137
2	118	115	140	145	141	120
3	152	120	128	155	138	126
4	137	116	152	140	157	118
5	116	118	146	130	142	118
6	162	118	130	142	151	130
7	155	120	119	155	140	140
8	142	125	130	160	145	120

(10 marks)

(d) Outline the significance of using the appropriate type of bentonite in the manufacture of GCL.

(5 marks)

Q5.

(a) Describe and illustrate what is meant by strip drain "smear" as probably occurs during installation.

(5 marks)

(b) Briefly explain the meaning of "kinking " as might occur in the performance of strip drain?

(5 marks)

(c) Calculate the allowable flow rate for a strip drain if the laboratory measured value using solid plate as described in ASTM was 2.8 x 10^{-3} m^3/min by referring to Table 3.

(9 marks)

(d) Check the factor of safety for the problem **Q5(c)** above if the strip drain is required to drain water at a rate of 10^{-4} m^3/min.

(6 marks)

Q6

(a) If the ultimate strength of a geotextile from an index-type test is 37.5 kN/m, calculate the average allowable strength for the design purposes according to Table 2 for separation?

(5 marks)

(b) Justify the benefit of using geotextiles as separator for unpaved roads on soft subsoils.

(5 marks)

(c) Calculate the number of fabric layers required to drain water from behind the following concrete cantilever retaining wall as shown in **FIGURE Q6** if each layer has a transmissivity of Θ_{allow} = 0.0011 m^3/min-m fabric. The soil backfill is a silty sand (ML-SW) with k = 0.003 m/min .

(9 marks)

(d) For the 4.3 m high concrete cantilever retaining wall of the question (c) above, recalculate the soil permeability to determine what value is required to have the Θ_{act} =0.0011 m^3/min-m be adequate with FS = 4.0 (i.e., work the problem backwards).

(6 marks)

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TABLE 2: RECOMMENDED PARTIAL FACTOR OF SAFETY VALUE

Application area	Various partial factors of safety			
	Installation damage	Creep*	Chemical degradation	Biological degradation
separation	1.1 to 2.5	1.0 to 1.2	1.0 to 1.5	1.0 to 1.2
cushioning	1.1 to 2.0	1.2 to 1.5	1.0 to 2.0	1.0 to 1.2
unpaved roads	1.1 to 2.0	1.5 to 2.5	1.0 to 1.5	1.0 to 1.2
walls	1.1 to 2.0	2.0 to 4.0	1.0 to 1.5	1.0 to 1.3
embankments	1.1 to 2.0	2.0 to 3.0	1.0 to 1.5	1.0 to 1.3
bearing capacity	1.1 to 2.0	2.0 to 4.0	1.0 to 1.5	1.0 to 1.3
slope stabilization	1.1 to 1.5	1.5 to 2.0	1.0 to 1.5	1.0 to 1.3
pavement overlays	1.1 to 1.5	1.0 to 1.2	1.0 to 1.5	1.0 to 1.1
railroads	1.5 to 3.0	1.0 to 1.5	1.5 to 2.0	1.0 to 1.2
flexible forms	1.1 to 1.5	1.5 to 3.0	1.0 to 1.5	1.0 to 1.1
silt fences	1.1 to 1.5	1.5 to 2.5	1.0 to 1.5	1.0 to 1.1

*The low end of the range refers to results that have been compensated for creep in the performance of the tests.

$$T_{\text{allow}} = T_{\text{ult}} \left(\frac{1}{FS_{ID} \times FS_{CR} \times FS_{CD} \times FS_{BD}} \right)$$

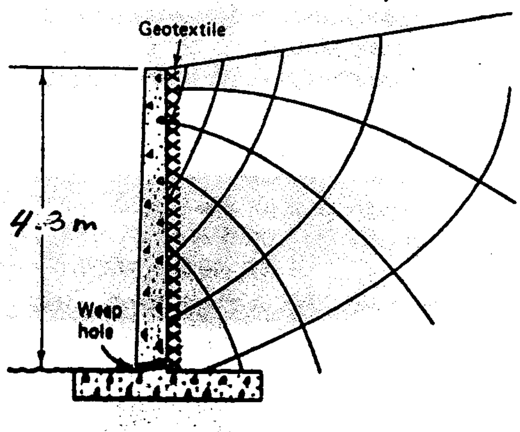

FIGURE Q6

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Table 3 : RECOMMENDED FACTOR OF SAFETY VALUE FOR ALLOWABLE FLOW RATE OF GEOCOMPOSITE

	Factor of safety values for Equation 6.3			
Application area	FS_{IN}	FS_{CR}*	FS_{CC}	FS_{BC}
Sport fields, capillary breaks	1.0 to 1.2	1.0 to 1.2	1.0 to 1.2	1.1 to 1.3
Roof and plaza decks	1.2 to 1.4	1.0 to 1.2	1.0 to 1.2	1.1 to 1.3
Retaining walls, seeping rock and soil slopes	1.3 to 1.5	1.2 to 1.4	1.1 to 1.5	1.0 to 1.5
Drainage blankets	1.3 to 1.5	1.2 to 1.4	1.0 to 1.2	1.0 to 1.2
Surface water drains for landfill caps	1.3 to 1.5	1.2 to 1.4	1.0 to 1.2	1.2 to 1.5
Secondary leachate collection (landfill)	1.5 to 2.0	1.4 to 2.0	1.5 to 2.0	1.5 to 2.0
Primary leachate collection (landfill)	1.5 to 2.0	1.4 to 2.0	1.5 to 2.0	1.5 to 2.0
Strip (wick) drains**	1.5 to 2.5	1.0 to 2.5	1.0 to 1.2	1.0 to 1.2
Highway edge drains	1.2 to 1.8	1.5 to 3.0	1.1 to 1.5	1.0 to 1.2

*These values assume that the q_{ult} value was obtained using an applied normal pressure of 2 to 3 times the field anticipated maximum value. If not, the values must be increased.

**An additional term for kinking must be included, where FS_{KG} = 1.0 to 4.0.