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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2014/2015

COURSE NAME	:	GEOSYNTHETICS ENGINEERING
COURSE CODE	:	BFG 4043/BFG 40403
PROGRAMME	:	BACHELOR OF CIVIL ENGINEERING WITH HONOURS
EXAMINATION DATE	:	JUNE 2015/JULY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTION IN **SECTION A**, AND **THREE (3)** QUESTIONS IN **SECTION B**

THIS QUESTION PAPER CONSISTS OF **FIFTEEN (15)** PAGES

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SECTION A

Q1 (a) Geosynthetics are now an accepted civil engineering construction material and have unique characteristics like all other construction material such as steel, concrete, timber, etc.Geotextiles and geogrids are two common planar products of a geosynthetics product.

(i) Write a brief definition of geotextiles and geogrids.

(3 marks)

(ii) List out **THREE (3)** production types for both geotextiles and georgrids product.

(3 marks)

(b) **Table 1** summarises the primary function of geosynthetics in geotechnical application. State the purpose(s) of each geosynthetics function for its application areas as listed below.

(i) The reinforcement in embankments; and steep slopes.

(2 marks)

(ii) The separation in railway trackbed; and subsurface drainage filter.

(2 marks)

(iii) The drainage and filtration in embankments; subgrade level; railway trackbed; and steep slopes.

(2 marks)

(c) **FIGURE Q1(c)(i)** illustrates a schematic diagram of a revetment structure for the erosion controller.

(i) Stability of cover layer, sublayers, subsoil considering the whole system as well as the individual element, is one of the design requirement or the aspects must be taken into account in the design process.

Outline another **FOUR (4)** requirement.

(4 marks)

(ii) Consider a revetment system as shown in **FIGURE Q1(c)(i)** with the following parameters:

Wave height, H are 0.3 m, 0.6 m, 1.2 m, 1.8 m, and 2.4 m
Unit weight of protective covering material, γ_c, is 24 kN/m^3
Unit weight of water, γ_w is 10 kN/m^3

Plot a graph between the wave height, H and the minimum depth of the protective covering, D.

The graph grid is attached in **FIGURE Q1(c)(ii)**.

(9 marks)

SECTION B

Q2 (a) Historically, construction of embankments is costly and environmentally sensitive when very soft soils, especially in wetlands, are encountered. The primary problem with these soft soils results from their low shear strength and excessive consolidation settlements requiring special construction practices and leading to high construction costs.

(i) Outline and sketch **THREE (3)** potential failure modes for an embankment over the soft foundation soil with a basal geosynthetic layer.

(6 marks)

(ii) One of the conventional solution is to remove and replace the soft soil. List another **TWO (2)** conventional solutions and **TWO (2)** benefits of the geosynthetics installation.

(4 marks)

(b) **FIGURE Q2(a)** illustrates a proposed slope for a new construction works which consists of a clay embankment soils. An additional line load, q of 10 kN/m is required to be constructed at the upper side. The design parameter, namely the embankment soils and foundation soils are attached on the figure. The minimum safety factor is 1.30.

The allowable tensile strength is 50 kN/m and its placed along the surface between the foundation soil and the embankment soil, as shown in **FIGURE Q2(b)**.

(i) Determine the safety factor without geotextitle reinforcement as illustrated in **FIGURE Q2(a)**.

(7 marks)

(ii) Determine the safety factor with geotextitle reinforcement as illustrated in **FIGURE Q2(b)**. The geotextile placed at one meter intervals from the foundation interface to the top of the embankment.

Assume that sufficient anchorage behind the slip circle shown is available to mobilize full geotextile strength.

(5 marks)

(iii) What ideas can you add to increase the safety factors based on the calculated values in the previous answer, i.e., with and without the geotextile reinforcement?

(3 marks)

Q3 (a) Geosynthetics used in roadways on soft subgrades, may provide several cost and performance benefits. With the composite functions of reinforcement and separation, it will ensure to reduce the thickness of aggregate required to stabilize the subgrade.

Outline other **FOUR (4)** application area benefits in the design together with its geosynthetics function.

(8 marks)

Q3 (b) The requirement of a separator functions in a temporary and unpaved roads is extremely essentials.

(i) Vehicle passes are one of the factors which to be considered through the design. Point out another **FIVE (5)** factors.

(5 marks)

(ii) There are **TWELVE (12)** procedure steps of a temporary and unpaved roads. The first step is to determine the soil subgrade strength. This in situ subgrade soil strength is carried out by CBR's test. In addition, the other relevant in situ tests which can be apply is static cone penetrometer test (CPT) or dilatometer (DMT).

Formulate briefly the other steps together with its appropriate methodology such, as explained in the first step in the previous paragraph.

(12 marks)

Q4 (a) **FIGURES Q4(a)** illustrate the examples of drainage applications. Point out any **FIVE (5)** with the correct application areas and discuss simply its geosynthetic functions.

(10 marks)

(b) **FIGURE Q4(b)** represents three graded distributions curve for a three samples for trench drain designs.

Integrate the appropriate design for the filtration as the primary function and separation as the secondary function. The design has to fullfil the required properties and its specification.

(15 marks)

Q5 (a) Geosynthetics are widely used for filtration in road works and railway constructions as well as coastal protection.

(i) Briefly point out **THREE (3)** requirements of filtration functions as to ensure the efficiency of the designs.

(6 marks)

(ii) Pore size of openings (O_{90} or O_{95}) is one of the factor to be included in specifications. Outline another **FOUR (4)** factors of filtration function.

(8 marks)

(b) **FIGURE Q5(a)** shows a 5.0 m high wall together with the flow net sketches.The body and base are 0.75 m width × 1.25 m height, and 1.50 m width × 1.25 m height, respectively. The requirement length for body and base of the wall are 5.0 m.

Tables 2 to **4** summarises the proposed backfill soil and geotextile filter fabric.

Design **TWO (2)** walls by referring the tables and the walls are in safe design by applying the reduction factor, RF as 15.00.

- END OF QUESTION -

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Table 1

Application Area	Functions	Products
Subgrade stabilization	reinforcement, separation, filtration	geotextile or geogrid
Railway trackbed stabilization	drainage, separation, filtration	geotextile
Steep slopes	reinforcement, drainage, filtration	geotextile
Asphalt overlays	stress-relieving layer and waterproofing	geotextile
Mechanically Stabilised Earth	reinforcement, drainage	geotextile or geogrid
Embankments	reinforcement, separation, filtration, drainage	geotextile
Subsurface drainage filter	filtration, and separation	geotextile or geogrid
Subsurface drainage	fluid transmission and filtration	prefabricated drainage composite

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Table 2

		Non wovens						
		200R	270R	360R	420R	600R	800R	1200R
Permittivity	sec^{-1}	2.00	2.00	1.50	1.35	1.20	1.00	0.70
AOS	mm	0.212	0.212	0.212	0.212	0.180	0.150	0.150

Table 3

		Wovens		
Permittivity	sec^{-1}	24-15	200W	400W
AOS	mm	0.05	0.05	0.05
		0.30	0.425	0.425

Table 4

		GM	SW1	SW2	SM
k_s	cm/s	0.005	0.005	0.01	0.00005
PI	%	0	0	0	0
C_c		2.8	1.0	2.1	3.0
C'_u		3.4	9.1	5.3	16.2
d'_{50}	mm	3.5	52	0.28	0.21
C_u		211	8.4	6.6	67
d_{50}	mm	5.0	0.60	0.28	0.22
d_{90}	mm	22	2.7	1.6	0.95

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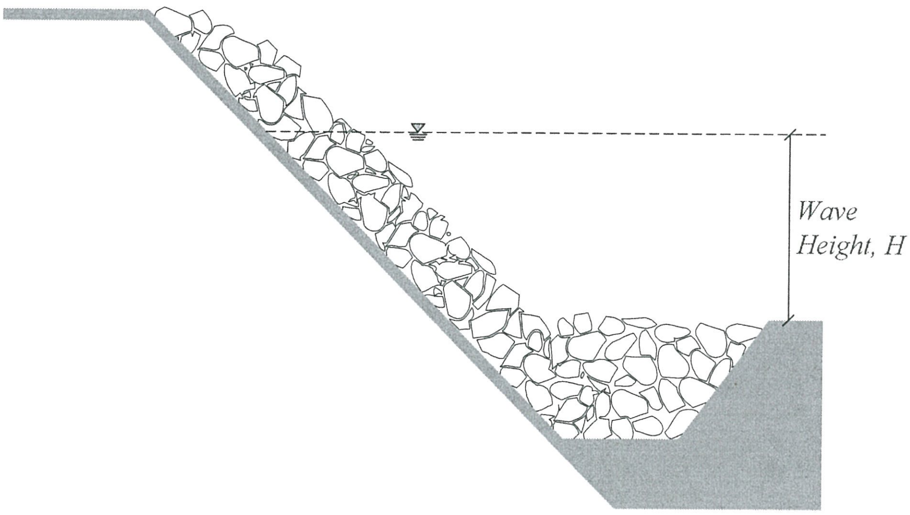

FIGURE Q1(c)(i)

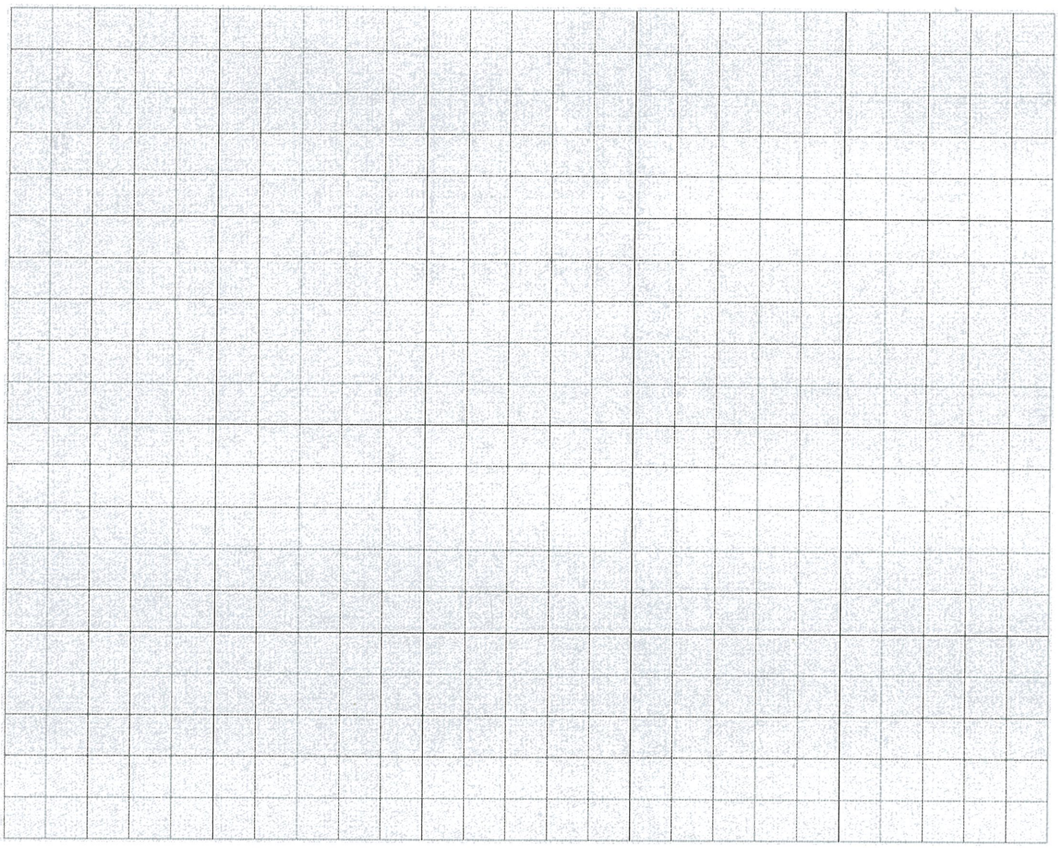

FIGURE Q1(c)(ii)

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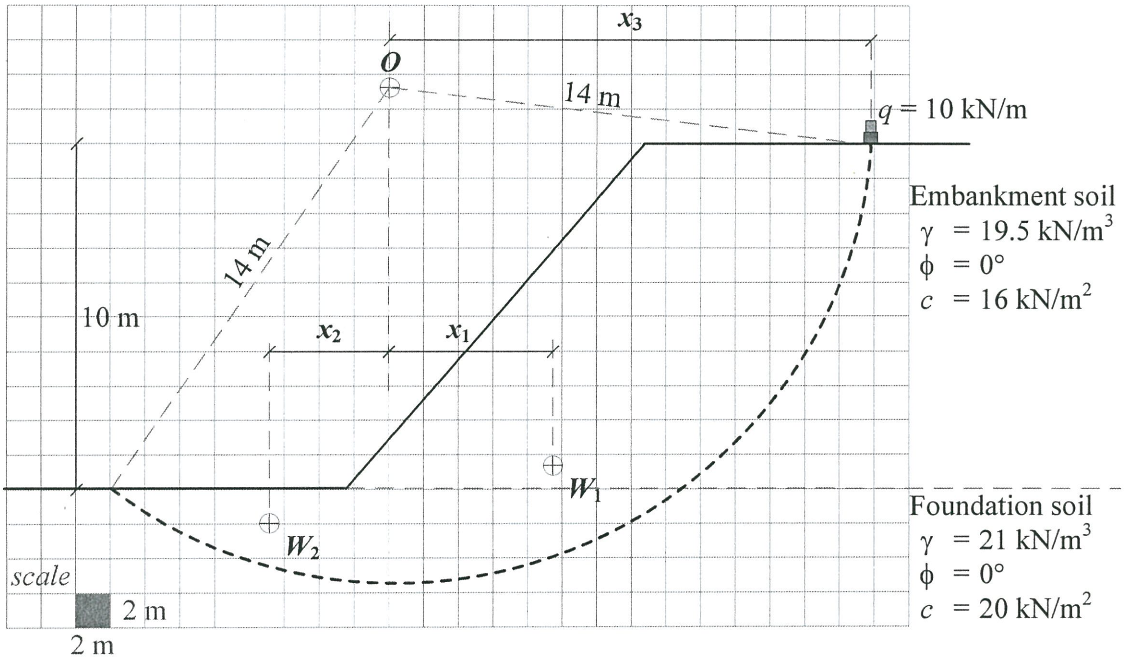

FIGURE Q2(a)

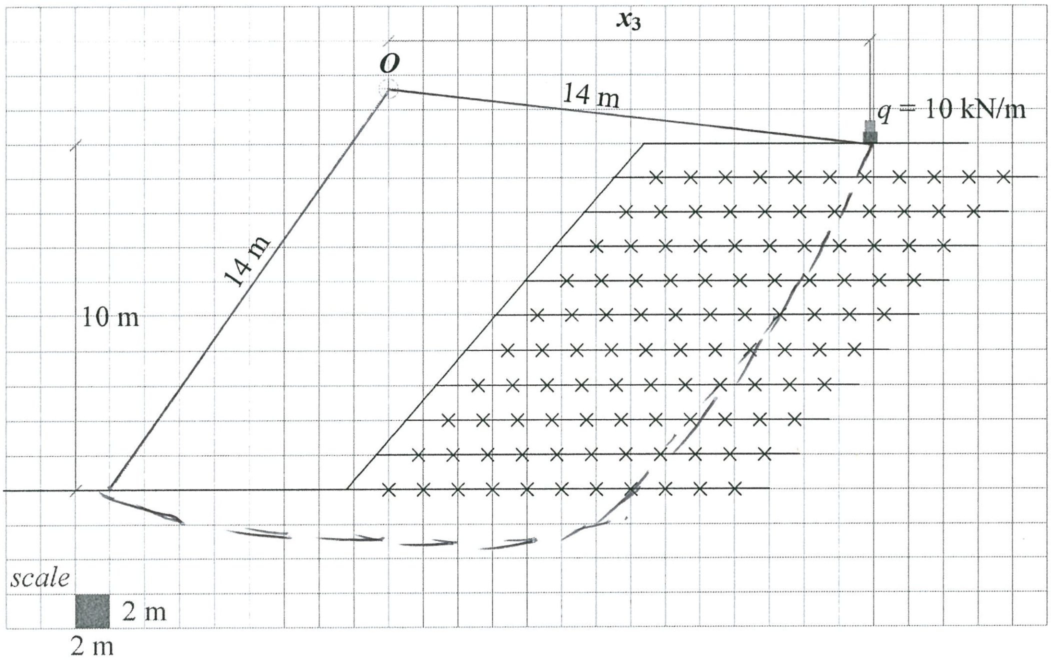

FIGURE Q2(b)

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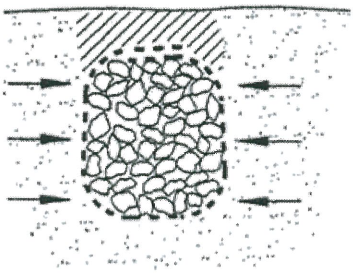

FIGURE Q4(a)(i)

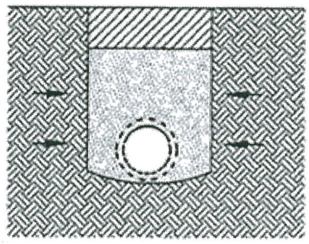

FIGURE Q4(a)(ii)

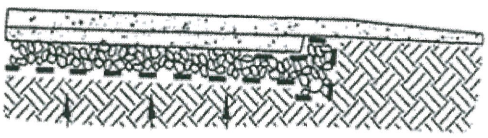

FIGURE Q4(a)(iii)

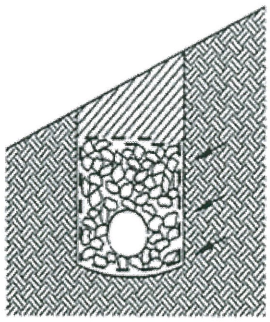

FIGURE Q4(a)(iv)

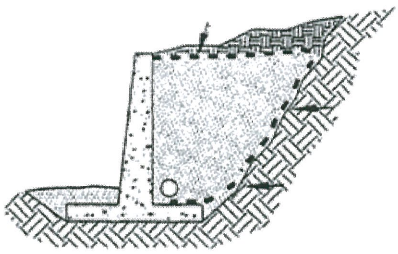

FIGURE Q4(a)(v)

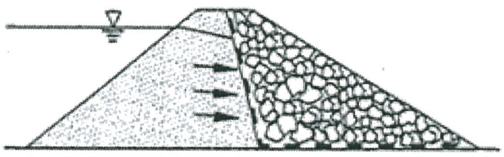

FIGURE Q4(a)(vi)

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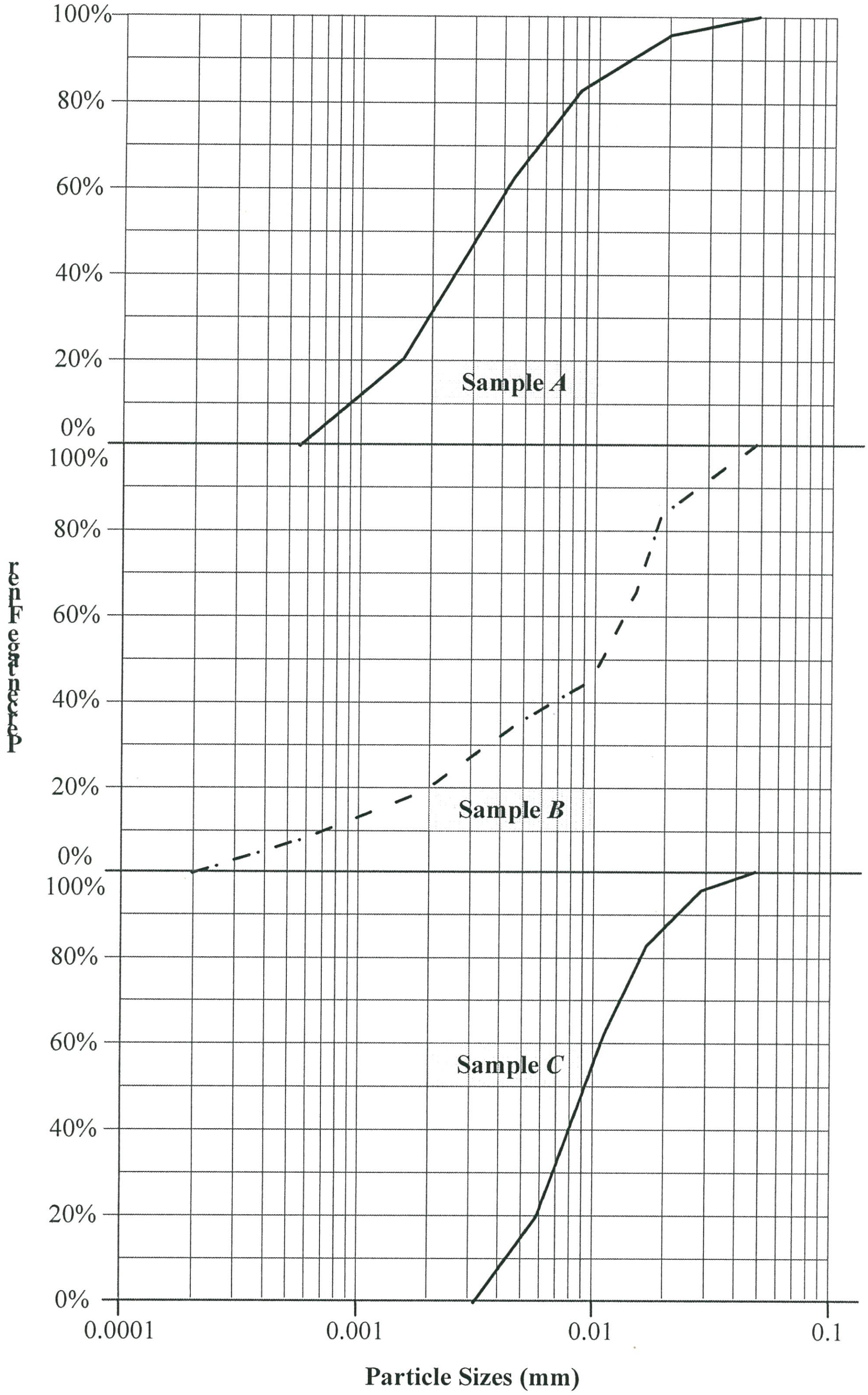

FIGURE Q4(b)

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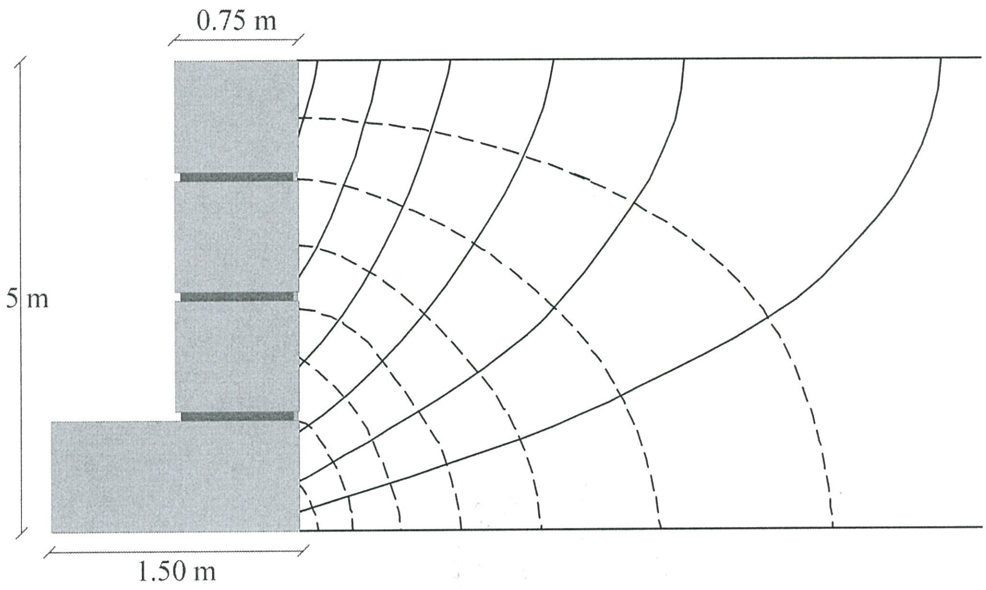

FIGURE Q5(a)

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FILTRATION DESIGN

$$q = kH\frac{F}{N}$$

$$q = k\frac{\Delta h}{t}A$$

$$q = kiA$$

$$\Psi_{required} = \frac{q}{\Delta hA}$$

$$\Psi_{allow} = \frac{\Psi_{ultimate}}{RF}$$

$$O_{95} < 2.5d_{85}$$

TRENCH DRAIN DESIGN

steady state flow

$$O_{95_{geotextile}} \leq BD_{85_{soil}}$$

For sands, gravelly sands, silty sands, and clayey sands (with less than 50% passing the 0.075 mm sieve:

$C_u \leq 2$ or $or \geq 8$ $B = 1$

$2 \leq C_u \leq 4$ and $B = 0.5C_u$

$4 < C_u < 8$ and $B = {}^{8}/_{C_u}$

$C_u = {}^{D_{60}}/_{D_{10}}$

For silts and clays (with more than 50% passing the 0.075 mm sieve), B is a function of the type of geotextile:

wovens; $B = 1; O_{95} \leq D_{85}$

nonwovens; $B = 1.8; O_{95} \leq 1.8D_{85}$

for both; AOS or $O_{95} \leq 0.3$ mm

dynamic flow

$$O_{95_{geotextile}} \leq 0.5D_{85_{soil}}$$

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TRENCH DRAIN DESIGN

Permeability requirements:
- for *less critical applications* and *less severe conditions*:

$k_{geotextile} \geq k_{soil}$

- and, for *critical applications* and *severe conditions*:

$k_{geotextile} \geq 10k_{soil}$

Permittivity requirements:

$\psi \geq 0.5$ sec^{-1} for < 15% passing 0.075 mm

$\psi \geq 0.2$ sec^{-1} for 15% to 50% passing 0.075 mm

$\psi \geq 0.1$ sec^{-1} for > 50% passing 0.075 mm

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SLOPE REINFORCEMENT

$$W_n = A_n \gamma_n$$

$$L_n = 2R\pi \frac{\theta^\circ}{360^\circ}$$

$$FS = \frac{c_n L_n R}{W_n x_n}$$

$$FS = \frac{c_n L_n R + \Sigma T_i y_i}{W_n x_n}$$

EROSION CONTROLLER

$$F_R > F_w$$

$$\Delta h < \frac{W_c' \cos\alpha}{\gamma_w}$$

$$S_N = \frac{H}{\gamma_R' D}$$

$$\gamma_R' = \frac{\gamma_c - \gamma_w}{\gamma_w}$$

for S_N

Unbonded riprap	< 2
Free blocks	< 2
Asphalt grouted open aggregate	< 4.3
Sand-filled mattresses	< 5
Articulated blocks	< 5.7
Grouted articulated blocks	< 8