Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2022/2023

COURSE NAME	:	GEOSYNTHETIC ENGINEERING DESIGN
COURSE CODE	:	BFG 40403
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	FEBRUARY 2023
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. ANSWER **ALL** QUESTIONS
		2.THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK.**
		3.STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

Q1 (a) Geosynthetics are usually sheet materials supplied in roll form and used in many geotechnical applications. There can be one or more functions that the geosynthetics serve in its performance life. Discuss the function of separation in geosynthetics application.

(10 marks)

(b) The use of geosynthetics has proliferated throughout a wide range of geotechnical applications such as to improve the filtration, drainage, and seepage control. A filter consists of any porous material that has openings small enough to prevent movement of soil into the drain. Based on **Figure Q1(b)**, explain the details of basic mechanisms involved in the filtration functions.

(15 marks)

Q2 (a) Geosynthetics have numerous application areas in civil engineering, especially in contact with soil, rock, and, /or any other civil engineering–related material. When a geosynthetic is used as a filter in drainage applications, it prevents upstream soils from entering adjacent granular layers or subsurface drains. Determine the application that uses the geosynthetics drains in civil engineering.

(5 marks)

(b) Given the following data:

For the granular backfill, the unit weight, $\gamma_b = 18 kN/m^3$; angle of internal friction, $\phi_b = 32°$.

For geotextile, allowable tensile strength, $\sigma_G = 35$ kN/m; Factor of safety against geotextile rupture = 1.5; Factor of safety against geotextile pullout = 1.5.

Based on the design procedure, determine the length of the geotextile layers, spacing of layers and lap lengths at a 10 m high geotextile-wrapped retaining wall.

(10 marks)

(c) Geosynthetics are used as a filter and/or a drain in many applications in geotechnics. For a geosynthetic to act as a filter and/or drain, it is essential that a condition of equilibrium is established at the soil/geosynthetic interface after installation to prevent soil particles from being piped indefinitely through the geosynthetic. Based on your reading and geotechnical understanding, describe the application guidelines that can be useful in geosynthetics filters and drains.

(10 marks)

Q3 (a) Richardson (1997a) presented a simple separation function design method (SFDM) for geosynthetic-reinforced unpaved roads. Determine the steps design method suggested by Richardson.

(5 marks)

(b) Consider the number of passes, N = 6000, single axle load, P = 90 kN, tyre inflation pressure, pc = 550 kPa, cohesive subgrade soil, CBR = 1.0, modulus of geotextile, E = 90 kN/m, and allowable rut depth, r = 40 mm. Based on **Table Q3(b)** and **Figure Q3(b)**, determine the required thickness of granular layer for the unpaved road without geotextile and with geotextile.

(10 marks)

(c) Steward et al. (1977) presented a design method for geosynthetic-reinforced unpaved roads, considering mainly the separation function of the geosynthetic. Describe the basic principles of the reinforcement function design method, separation function design method, and CBR design method for geosynthetics – reinforced unpaved roads.

(10 marks)

Q4 (a) An embankment of 3.5 m high and 7 m wide will be built on soft ground with a basal geotextile layer. Compute the geotextile strength and modulus required in order to prevent block sliding on the geotextile. Assume that the embankment material has a unit weight of 17 kN/m^3 and angle of shearing resistance of 32°. The geotextile-soil interface angle of shearing resistance is two – thirds of the value.

(9 marks)

(b) Any geosynthetic applied as reinforcement has the main task of resisting applied stresses or preventing inadmissible deformation in geotechnical structures. This can be illustrated by **Figure Q4(b)**, which shows the ideal reinforcement layout in geotechnical engineering. Based on **Figure Q4(b)**, determine the suitable applications of construction for reinforced soil.

(8 marks)

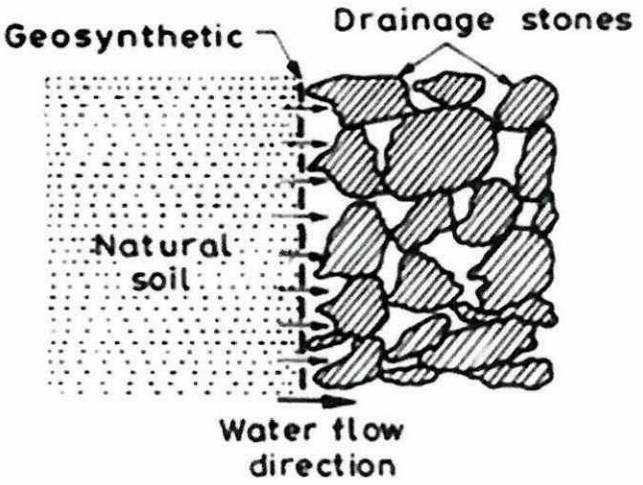
(c) The fluid barrier function of the geosynthetic should be achieved in roadways application such as to improve surface drainage or irrigation near pavement. Describe the process that cause the deterioration of base and subgrade due to the failure of fluid barrier function.

(8 marks)

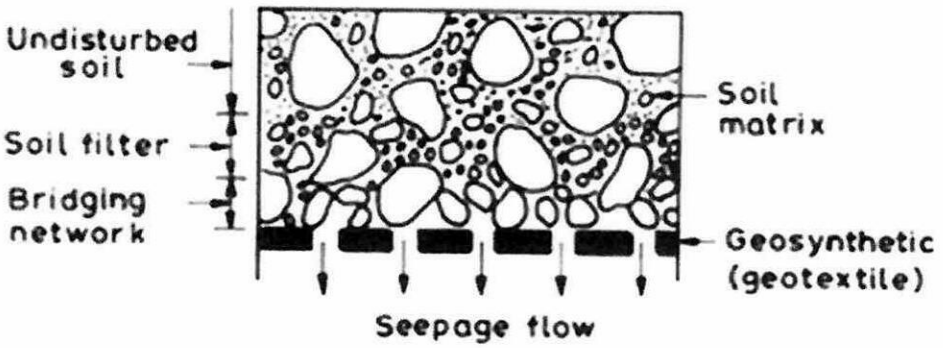
- END OF QUESTIONS -

FINAL EXAMINATION

SEMESTER/SESSION	:	1 / 2022/2023	PROGRAMME CODE	:	BFF
COURSE NAME	:	GEOSYNTHETIC ENGINEERING DESIGN	COURSE CODE	:	BFG 40403



(i)



(ii)

Figure Q1(b): Geosynthetic Filter

Table Q3(b): Bearing capacity factors for different ruts and traffic conditions both with without geotextile separators (after Steward et al., 1977)

Field site situation	*Ruts (mm)*	*Traffic (passes of 80 kN axle equivalents)*	*Bearing capacity factor, N_c*
Without geotextile	Less than 50	Greater than 1000	2.8
	Greater than 100	Less than 100	3.3
With geotextile	Less than 50	Greater than 1000	5.0
	Greater than 100	Less than 100	6.0

FINAL EXAMINATION

SEMESTER/SESSION : 1 / 2022/2023
COURSE NAME : GEOSYNTHETIC ENGINEERING DESIGN
PROGRAMME CODE : BFF
COURSE CODE : BFG 40403

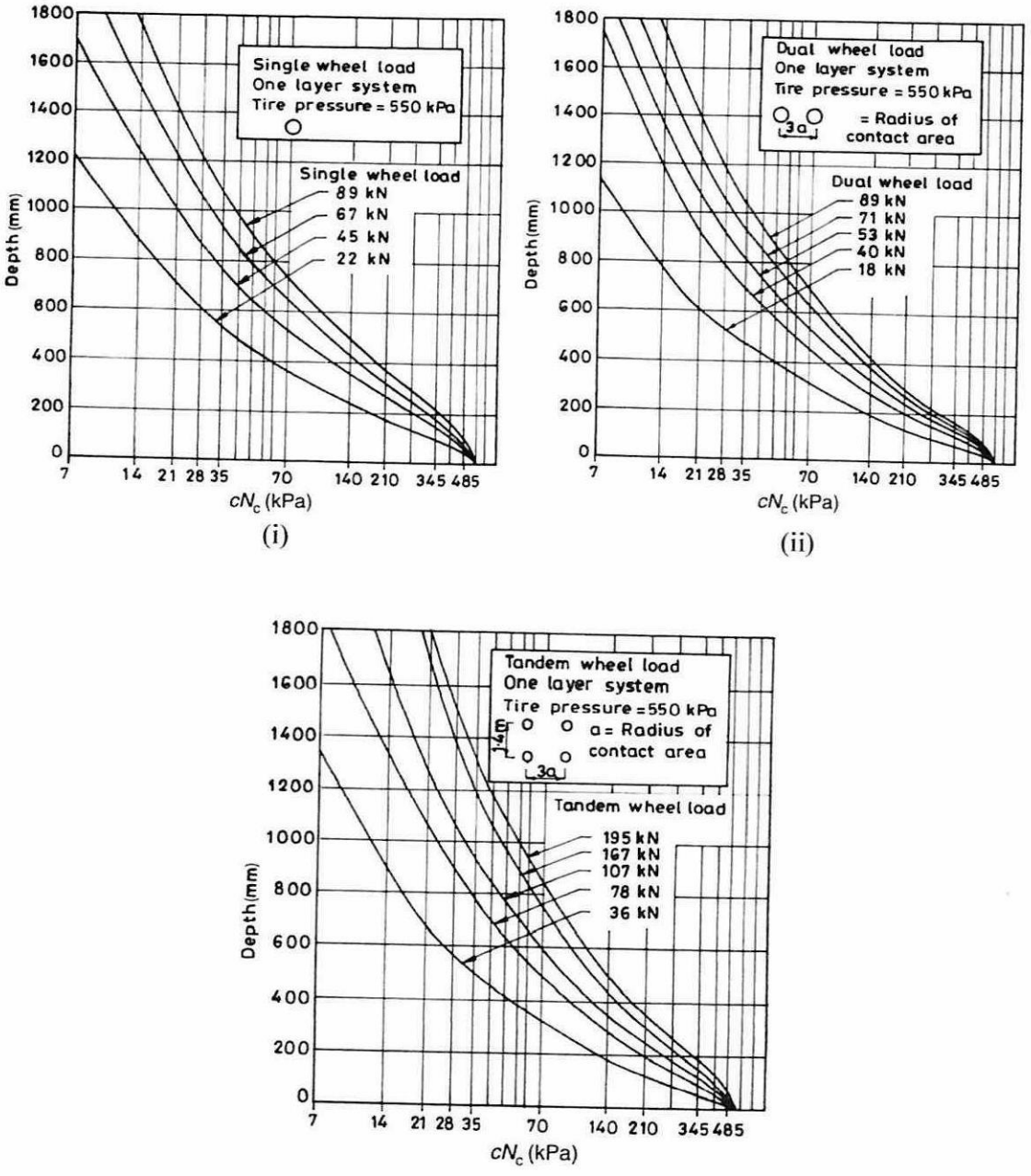
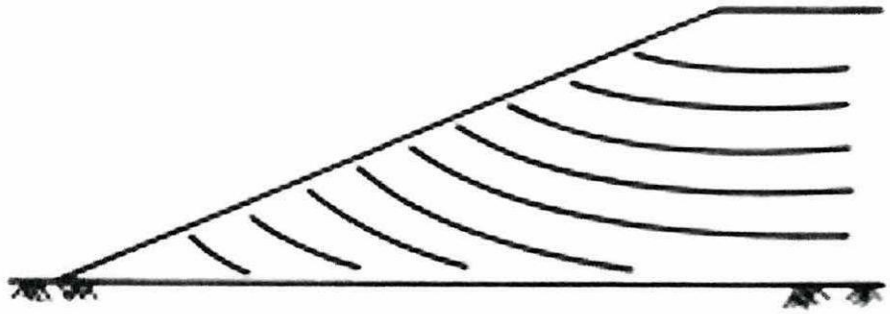


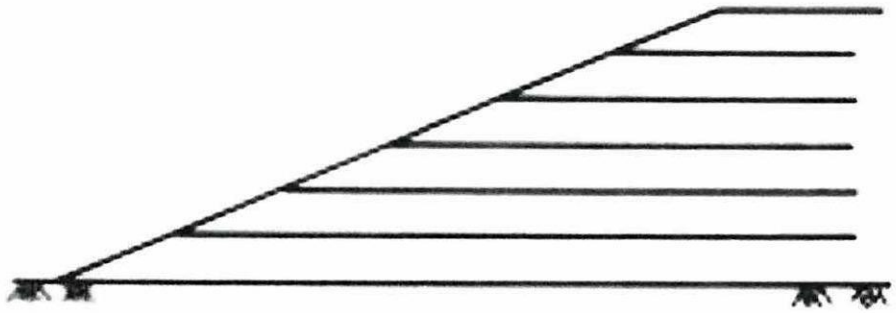
Figure Q3(b): US Forest service design charts for the geotextile-reinforced unpaved roads for: (i) single whee load; (ii) dual wheel load, and (iii) tandem wheel load (after Steward et al., 1977)

FINAL EXAMINATION

SEMESTER/SESSION	:	1 / 2022/2023	PROGRAMME CODE	:	BFF
COURSE NAME	:	GEOSYNTHETIC ENGINEERING DESIGN	COURSE CODE	:	BFG 40403



(i)



(ii)

Figure Q4(b): Reinforcement orientation: (i) idealized; (ii) practical (after Ingold, 1982a)