Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2021/2022

COURSE NAME	:	GEO SYNTHETICS DESIGN
COURSE CODE	:	BFG 40403
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JANUARY / FEBRUARY 2022
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. ANSWER **ALL** QUESTIONS. 2. THIS FINAL EXAMINATION IS AN **ONLINE** ASSESSMENT AND CONDUCTED VIA **CLOSE BOOK**.

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

Q1 (a) The design of a structure incorporating geosynthetics aims to ensure its strength, stability and serviceability over its intended life span. There are mainly four design methods for the geosynthetic-related structures or systems, which are Design-by-experience, Design-by-cost-and-availability, Design-by-specification and Design-by-function.

Briefly explain the details of each design methods.

(16 marks)

(b) Geosynthetics, such as geotextile and geogrid, are commonly used for the reinforcement of unpaved roads. The geosynthetics can reduce the thickness of aggregate required above soft subgrade and improve the durability of the unpaved road. Both geotextile and geogrid perform similar functions and often equivalently. However, the similar functions come from different reinforcement mechanisms.

Analyze and evaluate the similarity and/or differences in between the reinforcement mechanisms of geotextiles and geogrid. A relevant sketch is compulsory to illustrate the use of geotextile and/or geogrid as reinforcement of unpaved roads.

(20 marks)

Q2 (a) AASHTO M288-06 covers six geotextile applications: Subsurface Drainage, Separation, Stabilization, Permanent Erosion Control, Sediment Control and Paving Fabrics. However, AASHTO M288-06 is not a design guideline. It is the engineer's responsibility to choose a geotextile for the application that takes into consideration site-specific soil and water conditions. When site conditions are unknown, engineers can refer to AASHTO M288-06 Survivability Default Classes for guidance.

(i) Based on the AASHTO M288–00 specifications, recommend the properties of a non-woven geotextile (elongation, $\varepsilon \geq 50\%$) required for its application as a separator between soil subgrade (with CBR = 10) and the granular base course under typical installation survivability conditions. It is assumed that a smooth working table will be placed and a 30 kPa ground pressure equipment will be utilized.

(5 marks)

(ii) Please specify the properties of a non-woven geotextile in the case that the aggregate cover thickness of the first lift over the geotextile exceeds 300 mm, and the aggregate diameter is less than 50 mm.

(5 marks)

(iii) Please propose the max. permeability, k_{soil} of the soil allowed in this case. Given that the flux, q is 100 gpm/ft^2 and the thickness of the geotextile is 25 mils.

(4 marks)

(b) On 6th of January 2001, a fill slope collapsed in Putrajaya, Malaysia. The failed slope was 25m in height. The failure caused the slope to pushed two reinforced earth walls and the recently completed jetty and boat docking facilities to collapse. The depth of the failure scar was about 2m with a failure length of about 50 m. As a consultant, you are required to propose and design an engineered slope of 1 to 1.5 with geogrid in order to reinstate the slope back to its original condition.

The details of the slope failure and its original profile are shown in **Figure Q2**. The proposed design should include:

(i) Design principles
(ii) Type(s) of geogrid required and its function
(iii) Construction sequence
(iv) A sketch of construction drawings.

(20 marks)

Q3 (a) A silt fence is a temporary vertical barrier composed of a sheet of geotextile supported by fencing or simply by posts, as illustrated in **Figure Q3**. The lower end of the geotextile is buried in a trench cut into the ground so that runoff will not flow beneath the fence.

The purpose of the permeable geotextile silt fence is to intercept and detain sediment from unprotected areas before it leaves the construction site. Silt fence are sometimes located around the entire downslope portion or perimeter of urban construction sites. Short fences are often placed across small drainage ditches (permanent or temporary) constructed on the site. Both applications are intended to function for one or two construction seasons or until grass sod is established. The fence reduces water velocity allowing the sediment to settle out of suspension.

Briefly describe the design concepts of silt fence with illustration of relevant sketches.

(10 marks)

(b) Design a 6 m Mechanical Stabilized Earth (MSE) wall using a geotextile as the reinforcement by consider one unit length of wall with one unit width of geotextile. The backfill is a compacted, coarse-grained soil with $\phi'_{cs} = 30°$, $\gamma_{sat} = 18kN/m^3$ and $k_{ac} = 0.3$. The surcharge load is found to be 20 kPa. The native soil is identified as clay with $\gamma_{sat} = 18kN/m^3$, $\phi'_{cs} = 32°$, $\phi'_b = 20°$, and undrained shear strength, s_u = 60kPa

The properties of geotextile is given as follow:
- Ultimate wide-width tensile strength = 58.5 kN/m;
- Soil-geotextile interface friction = 20°

Factor of safety for respective criteria is taken as:

- Factor of safety for installation damage, $FS_{ID} = 1.5$
- Factor of safety for creep, $FS_{CR} = 2.0$
- Factor of safety for chemical degradation, $FS_{CD} = 1.3$
- Factor of safety for biological degradation, $FS_{BD} = 1.3$
- Factor of safety for vertical spacing, $FS_{SP} = 1.3$
- Factor of safety against translation, $FS_T = 1.5$

Calculate:

(i) the allowable tensile strength of the geotextile
(ii) the vertical spacing at different wall heights.
(iii) the length of reinforcement required at the base for translation.
(iv) the total length of reinforcement at each level for internal stability.

(20 marks)

–END OF QUESTIONS–

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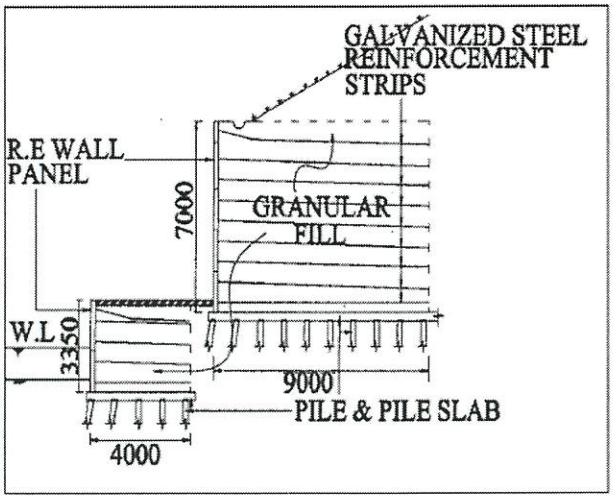
(a) The top portion of the failed slope



(b) Original RE wall design

Figure Q2: Details of a failed slope in Putrajaya, Malaysia
(Source: https://scholarsmine.mst.edu/icchge/5icchge/session07/5)

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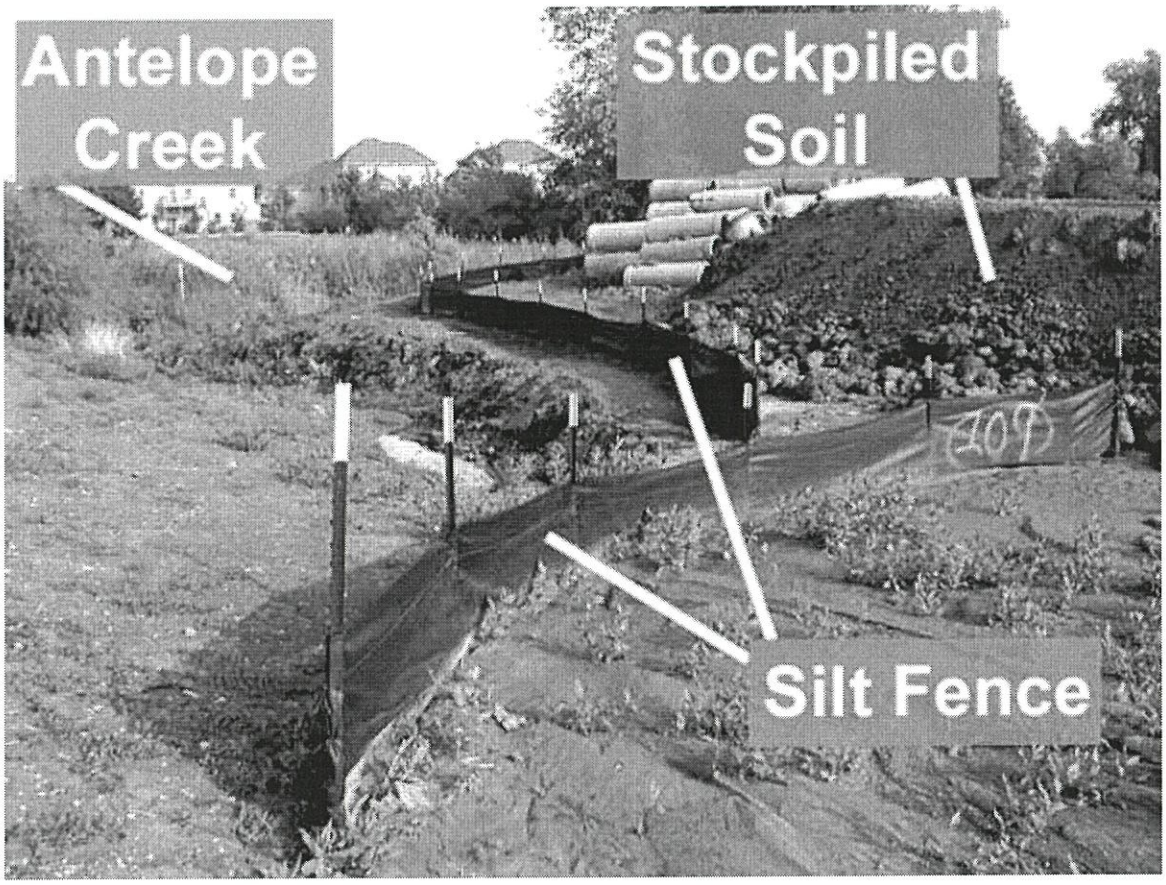

Figure Q3: Details of a row of typical silt fence
(Source: https://passel2.unl.edu/view/lesson/ca2a3ba0dc28/4)