UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2018/2019

COURSE NAME	:	GEOTECHNICS I
COURSE CODE	:	BFC21702
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	DECEMBER 2018 / JANUARY 2019
DURATION	:	2 HOURS
INSTRUCTION	:	1. ANSWER **ALL** QUESTIONS 2. WRITE YOUR ANSWER IN THE ANSWER BOOKLET

THIS QUESTION PAPER CONSISTS OF **TWELVE (12)** PAGES

Q1 (a) Atterberg limits properties of a soil sample are very impotant in soil classification which are commonly simplified in a chart. Define the shrinkage limit, plastic limit, liquid limit and plastic index based on Atterberg limits chart.

(4 marks)

(b) Two different samples were collected in Kuantan and Tronoh which are denoted as samples K and T, respectively. These samples were sieved for design purposes and the results are as shown in **Figure Q1(b)(i)**.

(i) Based on **Figure Q1(b)(i)**, determine the percentages of gravel, sand, silt and clay of each soil based on ASTM classification in **Figure Q1(b)(ii)**.

(4 marks)

(ii) By using the result from **Q1(b)(i)**, classify the sample K based on **Table Q1(b)** and **Figure Q1(b)(iii)** or **Figure Q1(b)(iv)**, given the plastic index of sample K is 5.5.

(4 marks)

(iii) Classify the sample T based on **Table Q1(b)** and **Figure Q1(b)(iii)** or **Figure Q1(b)(iv),** given liquid limit and plastic limit of sample T is 45% and 39.8%, respectively.

(4 marks)

(c) The results of compaction test in the laboratory using the standard proctor method for the Ayer Hitam residual soil are tabulated in **Table Q1(c)**. After compaction of the soil in the laboratory, the field density tests using the sand cone replacement method were performed. Assume the specific gravity, $G_s = 2.65$.

(i) Determine the maximum dry density and optimum moisture content from compaction curve.

(5 marks)

(ii) Ayer Hitam residual soil will be used as a compacted layer with thickness of 4 m high. If the moisture content of the compacted soil at the field is 15.8%, determine the vertical stress (kN/m^3) at a depth of 2.5 m from the ground surface.

(4 marks)

Q2 (a) Explain briefly with the aid of diagrams, the saturated, unsaturated and dry soil condition.

(6 marks)

(b) A weight of 78.5 N undisturbed soil sample was collected from the field in steel tubes for laboratory test. The tube sample has a diameter of 85 mm, length of 700 mm. If the oven dried weight was 65.85 N, and $G_s = 2.65$, determine the dry unit weight (kN/m^3), void ratio and degree of saturation

(9 marks)

(c) Sketch and discuss the differences between confined and unconfined aquifer of soil.

(4 marks)

(d) A cross section of a levee shown in **Figure Q2(d)** is 500 m long and is underlain by a 2 m thick permeable sand layer. It was observed that the quantity of water flowing through the sand layer into the collection ditch is 250 m^3/day. Determine the hydraulic conductivity of the sand layer.

(6 marks)

Q3 (a) The stresses in the soil are very important when dealing with Geotechnical construction. List **FOUR (4)** soil parameters that influence the stress in the soil.

(4 marks)

(b) A soil profile is shown in **Figure Q3(b)(i)**. The groundwater level is located on the ground surface. The sand layer is under artesian pressure where the excess pore water pressure is 40 kN/m^2.

(i) Calculate the total vertical stress, pore water pressure and effective vertical stress at the base of each layer.

(9 marks)

(ii) Determine the increment of the effective stress at the base of sand layer if the 1.5m height fill will be imposed on the ground surface. Note that, the density of the fill material is 1750 kg/m^3.

(4 marks)

(iii) The excavation will be made in the clay layer for the basement construction. Evaluate the stability of the soil from *boiling* or *quick condition*. The depth of the excavation is shown in **Figure Q3(b)(ii)**.

(4 marks)

(iv) Propose the maximum depth of cut that can be made to avoid boiling or quick condition.

(4 marks)

Q4 (a) Explain briefly the differences between CU, CD and UU in the triaxial test in terms of procedure and test results.

(4 marks)

(b) The deviator stress - strain curve obtained from a drained triaxial test for a normally consolidated soil obtained from Batu Pahat soft soil is shown in **Figure Q4(b)**.

(i) Identify the maximum deviator stress and the strain at maximum deviator stress.

(4 marks)

(ii) Determine the friction angle (ϕ') and cohesion (c') with the aid of the Mohr circle.

(7 marks)

(iii) Estimate the angle (θ) that the failure plane makes with the minor principle plane.

(2 marks)

(iv) Determine the effective normal stress on the plane of maximum shear stress.

(2 marks)

(v) Determine the normal and shear stresses when the specimen failed on a plane that makes an angle of 35° with the major principle plane.

(2 marks)

(c) Predict the results of cohesion and friction angle if the soil in **Q4(c)** is over consolidated soil. Justify your answer.

(4 marks)

– END OF QUESTIONS –

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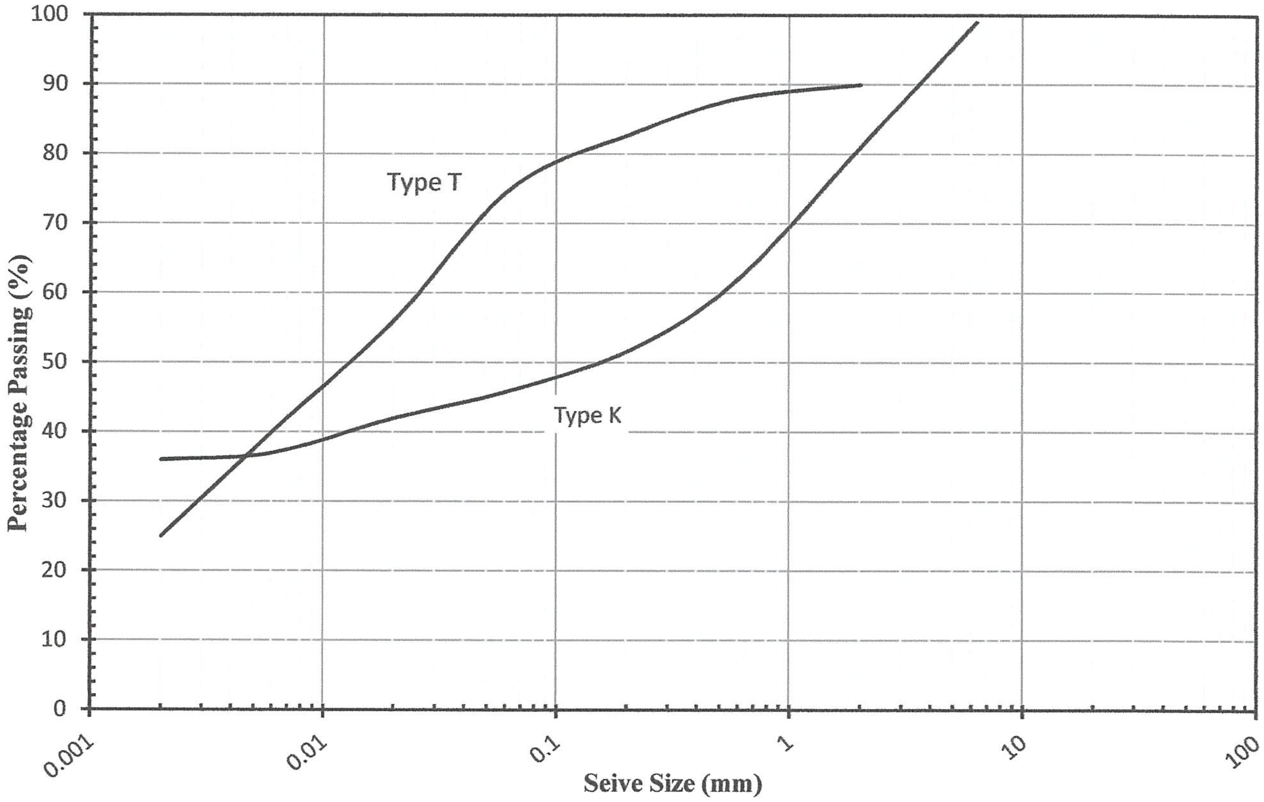

FIGURE Q1(b)(i): Results from particle size analysis collected in Kuantan and Seremban

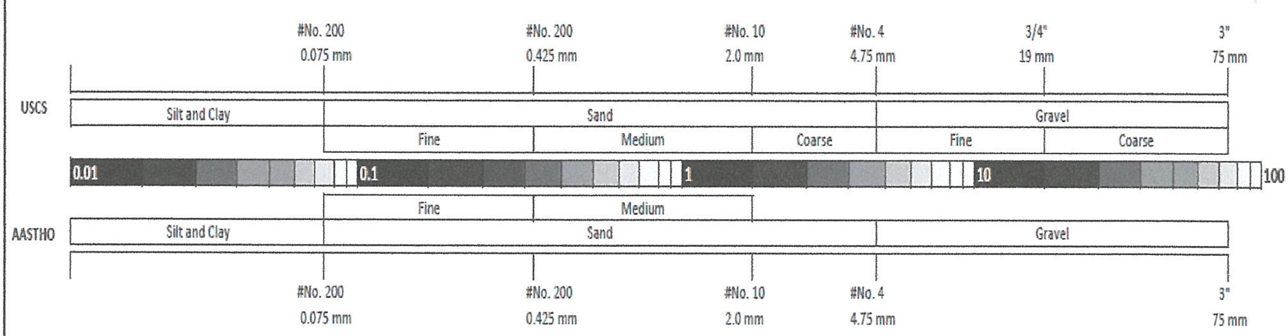

FIGURE Q1(b)(ii): Grain size of USCS and AASHTO classification systems

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TABLE Q1(b): The Unified Soil Classification System (USCS)

Criteria for assigning group symbols				**Group symbol**
Coarse-grained soils More than 50% retained on No. 200 sieve	**Gravels** More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[a]	$C_u \geq 4$ and $1 \leq C_c \leq 3$[c]	GW
			$C_u < 4$ and/or $C_c < 1$ or $C_c > 3$[c]	GP
		Gravels with Fines More than 12% fines[a,d]	$PI < 4$ or plots below "A" line	GM
			$PI > 7$ and plots on or above "A" line	GC
	Sands 50% or more of coarse fraction passes No.4 sieve	Clean Sands Less than 5% fines[b]	$C_u \geq 6$ and $1 \leq C_c \leq 3$[c]	SW
			$C_u < 6$ and/or $C_c < 1$ or $C_c > 3$[c]	SP
		Sands with Fines More than 12% fines[b,d]	$PI < 4$ or plots below "A" line	SM
			$PI > 7$ and plots on or above "A" line	SC
Fine-grained soils 50% or more passes No.200 sieve	**Silts and clays** Liquid limit less than 50	Inorganic	$PI > 7$ and plots on or above "A" line[e]	CL
			$PI < 4$ or plots below "A" line[e]	ML
		Organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$ OL zone	OL
	Silts and clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	CH
			PI plots on below "A" line	MH
		Organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$ OH zone	OH
Highly organic soils	Primarily organic matter, dark in color, and organic odor			Pt

[a]Gravels with 5 to 12% fine require dual symbils: GW-GM, GW-GC, GP-GM, GP-GC.
[b]Sands with 5 to 12% fines require dual symbols: SW-SM, SW-SC, SP-SM, SP-SC.
[c]$C_u = D_{60}/D_{10}$; $C_c = (D_{30})^2/D_{60} \times D_{10}$
[d]If $4 \leq PI \leq 7$, use dual symbol GC-GM or SC-SM.
[e]If $4 \leq PI \leq 7$, use dual symbol CL-ML.

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Group symbol		Group name
GW	<15% sand	Well-graded gravel
	≥15% sand	Well-graded gravel with sand
GP	<15% sand	Poorly graded gravel
	≥15% sand	Poorly graded gravel with sand
GW-GM	<15% sand	Well-graded gravel with silt
	≥15% sand	Well-graded gravel with silt and sand
GW-GC	<15% sand	Well-graded gravel with clay (or silty clay)
	≥15% sand	Well-graded gravel with clay and sand (or silty clay and sand)
GP-GM	<15% sand	Poorly graded gravel with silt
	≥15% sand	Poorly graded gravel with silt and sand
GP-GC	<15% sand	Poorly graded gravel with clay (or silty clay)
	≥15% sand	Poorly graded gravel with clay and sand (or silty clay and sand)
GM	<15% sand	Silty gravel
	≥15% sand	Silty gravel with sand
GC	<15% sand	Clayey gravel
	≥15% sand	Clayey gravel with sand
GC-GM	<15% sand	Silty clayey gravel
	≥15% sand	Silty clayey gravel with sand
SW	<15% gravel	Well-graded sand
	≥15% gravel	Well-graded sand with gravel
SP	<15% gravel	Poorly graded sand
	≥15% gravel	Poorly graded sand with gravel
SW-SM	<15% gravel	Well-graded sand with silt
	≥15% gravel	Well-graded sand with silt and gravel
SW-SC	<15% gravel	Well-graded sand with clay (or silty clay)
	≥15% gravel	Well-graded sand with clay and gravel (or silty clay and gravel)
SP-SM	<15% gravel	Poorly graded sand with silt
	≥15% gravel	Poorly graded sand with silt and gravel
SP-SC	<15% gravel	Poorly graded sand with clay (or silty clay)
	≥15% gravel	Poorly graded sand with clay and gravel (or silty clay and gravel)
SM	<15% gravel	Silty sand
	≥15% gravel	Silty sand with gravel
SC	<15% gravel	Clayey sand
	≥15% gravel	Clayey sand with gravel
SC-SM	<15% gravel	Silty clayey sand
	≥15% gravel	Silty clayey sand with gravel

FIGURE Q1(b)(iii): Flowchart group names for gravelly and sandy soils

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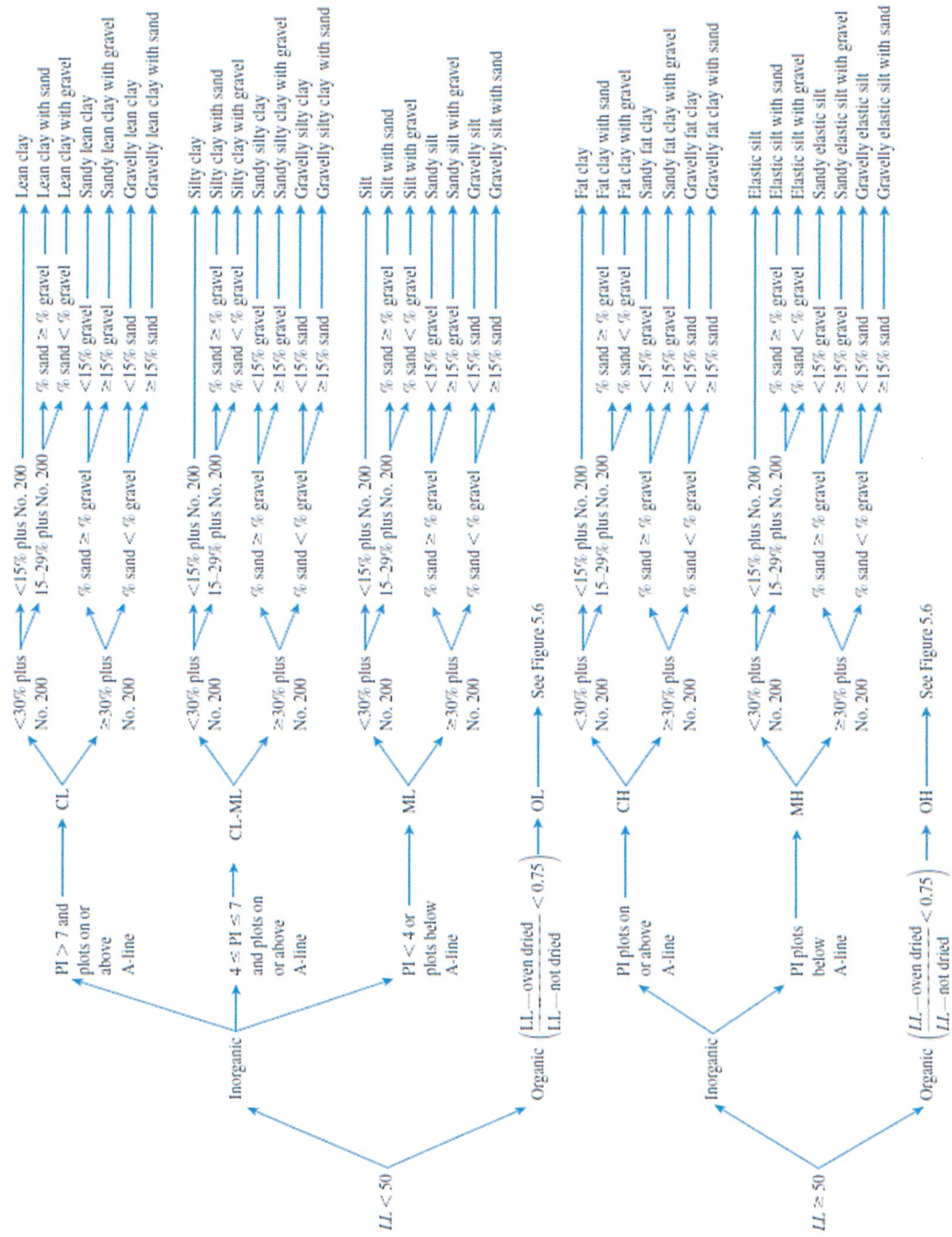

FIGURE Q1(b)(iv): Flowchart group names for inorganic silty and clayey soils

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TABLE Q1(c): Result from Standard Proctor Compaction Test

Test No.	1	2	3	4	5
Volume of Mold (cm^3)	948	948	948	948	948
Weight of Soil (g)	2048	2168	2206	2229	2162
Moisture Content, *w* (%)	12.8	13.6	14.2	15.4	18.2

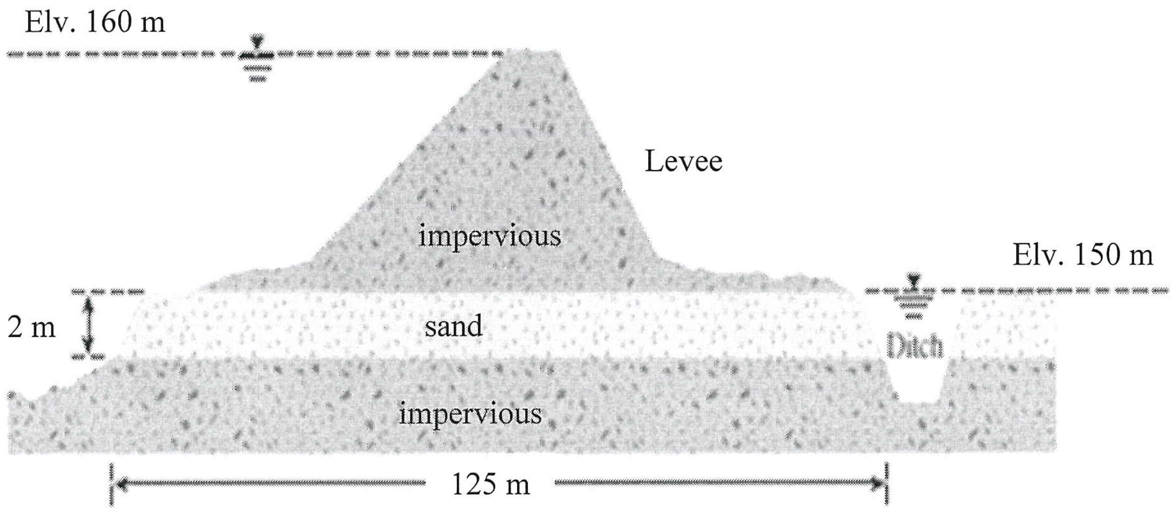

FIGURE Q2(d): Cross section of a levee

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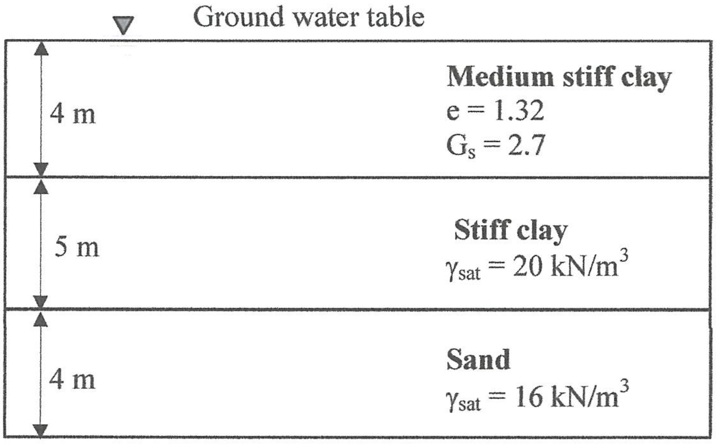

Useful equation:

$$\gamma_{sat} = \frac{(G_s + e)\gamma_w}{1 + e}$$

FIGURE Q3(b)(i): Soil profile

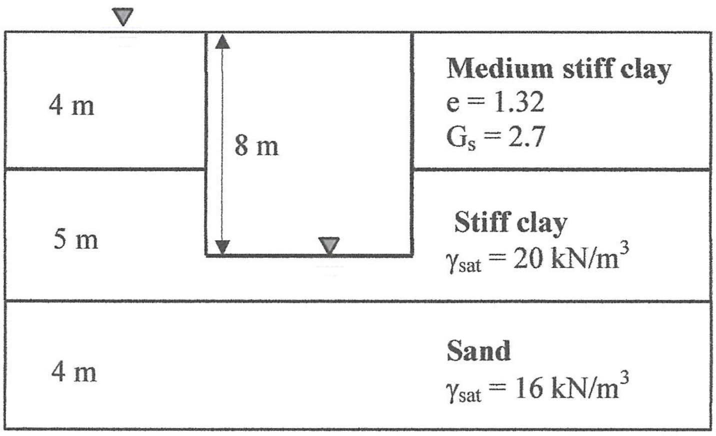

Figure Q3(b)(ii): Proposed excavation in clay layer

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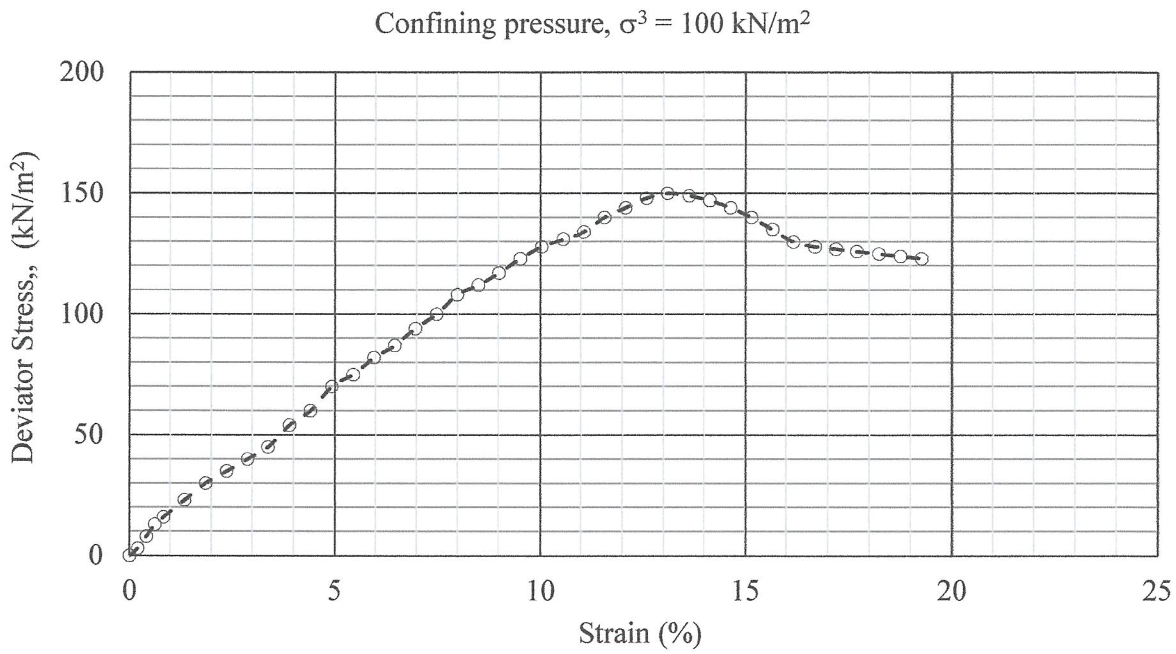

Figure Q4(b): Stress vs strain curve of normally consolidated clay

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The following information may be useful. The symbols have their usual meaning.

$$\gamma = \frac{W}{V_m}$$

$$\gamma_d = \frac{\gamma}{1 + \frac{w(\%)}{100}}$$

$$\gamma_d = \frac{G_s \gamma_w}{1 + \frac{G_s w}{S}}$$

$$\tau' = c + \sigma_n' \tan \phi'$$

$$E = \frac{\text{Number of Blow/Layer} \times \text{number of Layer} \times \text{Weight of Hammer} \times \text{Hight of Drop}}{\text{Mold Volume}}$$

$$\sigma_1 = \sigma_3 \tan^2\left(45^\circ + \frac{\phi}{2}\right) + 2c \tan\left(45^\circ + \frac{\phi}{2}\right)$$

$$\sigma_3 = \sigma_1 \tan^2\left(45^\circ - \frac{\phi}{2}\right) - 2c \tan\left(45^\circ - \frac{\phi}{2}\right)$$

$$\sigma_n = \frac{\sigma_1 + \sigma_3}{2} + \frac{\sigma_1 - \sigma_3}{2} \cos 2\theta$$

$$\tau_f = \frac{\sigma_1 - \sigma_3}{2} \sin 2\theta$$

$$k = 2.303 \frac{aL}{At} \log_{10} \frac{h_1}{h_2}$$

$$k = \frac{QL}{Aht}$$

$$k = \frac{q \log_{10}\left(\frac{r_1}{r_2}\right)}{2.727H(h_1 - h_2)}$$

$$k = \frac{2.303q \log_{10}\left(\frac{r_1}{r_2}\right)}{\pi(h_1^2 - h_2^2)}$$