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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2016/2017

COURSE NAME	:	GEOTECHNICS II
COURSE CODE	:	BFC 34402
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JUNE 2017
DURATION	:	2 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS IN **SECTION A** AND **TWO (2)** QUESTIONS IN **SECTION B**

THIS QUESTION PAPER CONSISTS OF **ELEVEN (11)** PAGES

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SECTION A

Q1 (a) The slope can be natural or man-made and can fail in various modes. With the aid of sketches, describe any **THREE (3)** major categories of slope failures.

(3 marks)

(b) A slope has been built in homogenous soils condition as shown in **Figure Q1(b)**. By using all the given data in **Table 1** and using the mass procedure method,

(i) compute the total moment of the driving force about point O.

(3 marks)

(ii) determine the factor of safety of the trial circle.

(7 marks)

(iii) What could happen to the moment of driving force and safety factor when the gradient and the height of the slope increases.

(2 marks)

(c) For the cut slope shown in **Figure Q1(c)**, find the factor of safety with respect to sliding by using the ordinary method of slices.

Please redraw the slope by using the provided graph paper with the scale 1cm = 1m. Divide the failure surface into 5 slices with the same width. Show all the procedures and necessary calculation in your answer.

(25 marks)

SECTION B

Q2 (a) Why is it expected that the maximum height of capillary rise is greater for fine-grained soils than for coarse-grained soils?

(9 marks)

(b) In western Miami-Dade County (**Figure Q2(b)**), the Everglades are contained with levees. Levee #111 runs North-South about 2 kilometers west of Krome Avenue and its cross section is show below. Laboratory tests indicate that the permeability of the 80-year old levee is 0.30 m/day. Calculate the volume of water lost through the levee along each kilometer in m^3/day.

(6 marks)

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(c) From **Figure Q2(c)**, assume the following data:
$H = 6.0$ m, $k = 4 \times 10^{-5}$ m/s, $\gamma_{sat} = 19.80$ kN/m^3 (sand)
Distances: AB = 2 m, BC = 2 m, CD = 1.5 m, DE = 1 m. Calculate:

(i) flow quantity/day, Q per meter of wall (Given that 1 day = 86400sec).

(6 marks)

(ii) pore pressure at points C, D and E.

(9 marks)

Q3 (a) Figure **Q3(a)** shows a unit of semi gravity retaining wall. The height behind the retaining wall is 6.0 m. The backfill behind the retaining walls is horizontal. The soil parameters are as shown. Take concrete unit weight as 24 kN/m³.

As an engineer at a consultant company, your task is to design the followings by using Rankine method :

(i) Active pressure.

(16 marks)

(ii) Location of the resultant force.

(7 marks)

(b) Given an embankment as shown in **Figure Q3(b)**. Old pipe line is at point A and can sustain maximum of 120 kN/m^2 vertical stress. Analyze whether the pipe line is still usable.

(7 marks)

Q4 (a) The consolidation process of a fully saturated clayey soil can best be explained by a model known as piston-spring analogy. Briefly, explain the process by using the piston spring analogy diagram.

(5 marks)

(b) A 2 m clay layer underlies a sand layer of 4 m depth as shown in **Figure Q4(b)**. The groundwater level was observed to be very deep. The unit weight of the sand layer is 17 kN/m^3 while the clay layer is 19 kN/m^3. The structure load will develop stress at 100 kPa. It was observed that in place void ratio is 0.73. The collected data from the laboratory consolidation test were shown in **Table 2**.

(i) Make necessary calculations and draw an e versus $\log \sigma'$ curve based on given data in **Table 2**. Given dry mass of specimen = 100 g, height of specimen at the beginning of the test = 20 mm, specific gravity = 2.7 and specimen surface area = 32 cm^2.

(10 marks)

(ii) Determine preconsolidation pressure, compression index and swell index.

(6 marks)

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(iii) What is the settlement of the clay layer caused by primary consolidation if the clay is over consolidated ?

(4 marks)

(iv) What is the settlement of the clay layer caused by primary consolidation if the clay is normally consolidated and the groundwater level was located at the middle of sand layer ?. Given the saturated unit weight of the sand layer is $18kN/m^3$ while the clay layer is $19.5kN/m^3$.

(5 marks)

- END OF QUESTIONS -

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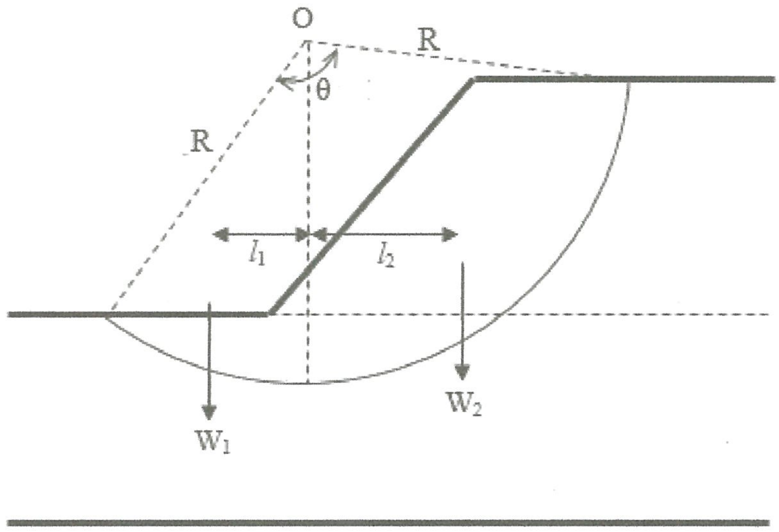

TABLE 1

W_1 (kN)	257
W_2 (kN)	693
l_1 (m)	2.75
l_2 (m)	4.67
θ (°)	95
R (m)	9.5
C_u (kN/m^2)	37
γ (kN/m^3)	19

FIGURE Q1(b) : The slope

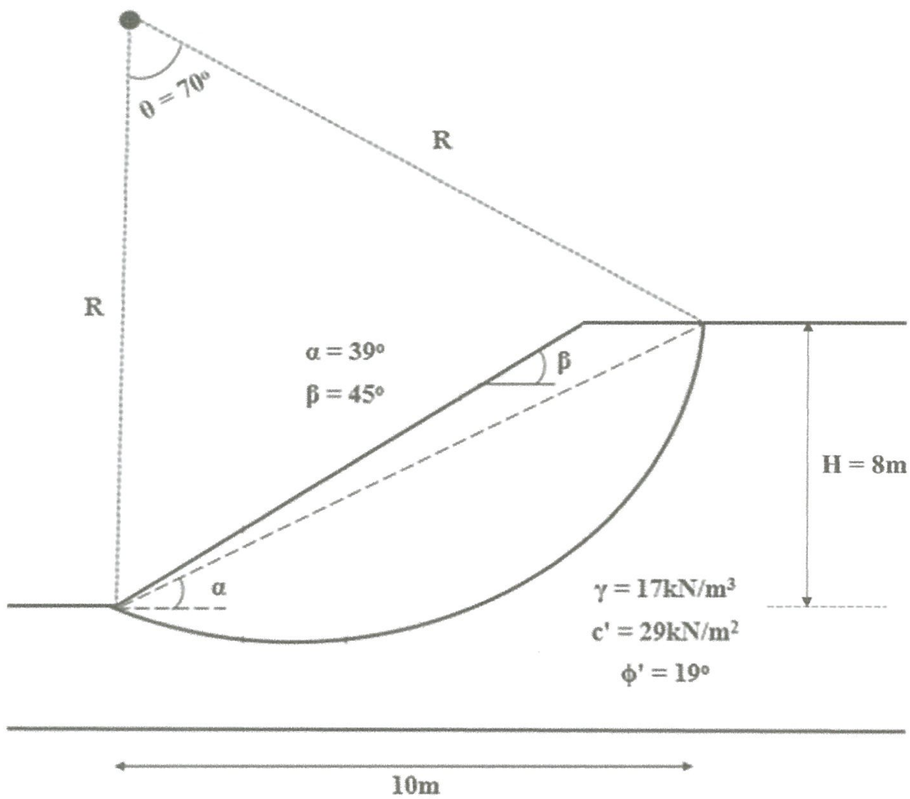

FIGURE Q1(c) : The cut slope

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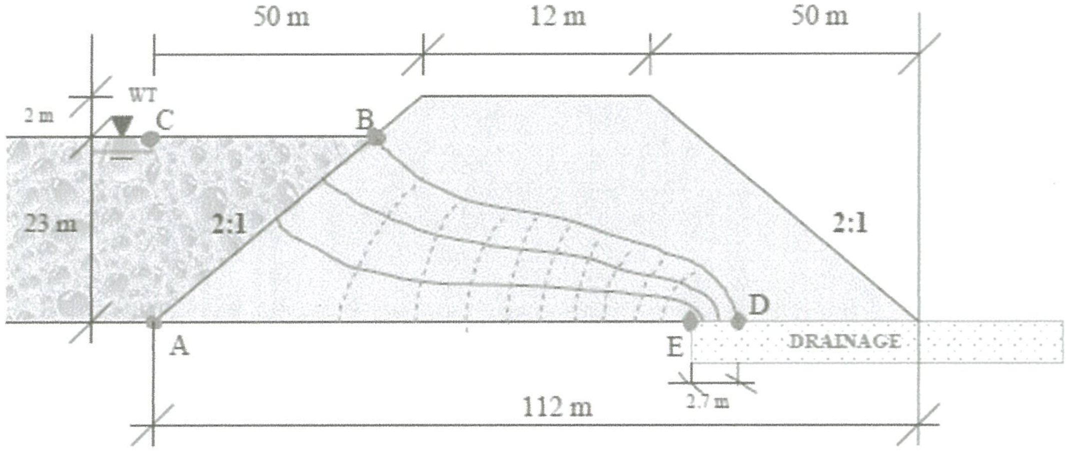

Cross-section of levee looking north.

FIGURE Q2(b) : Flow net

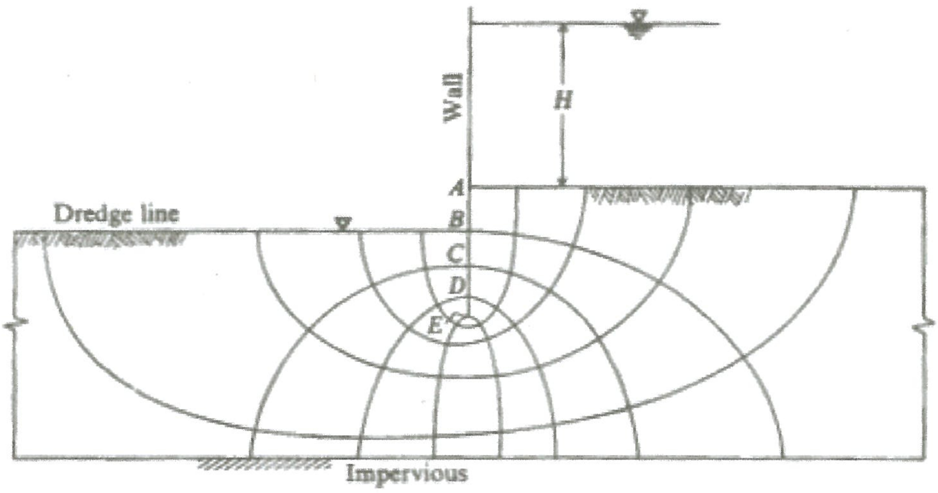

FIGURE Q2(c) : Flow net

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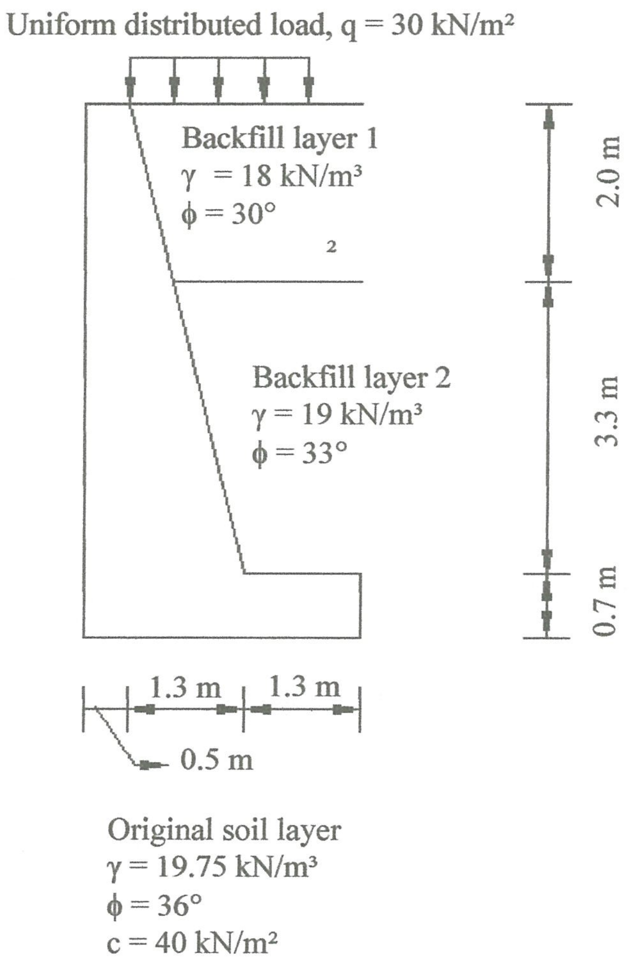

FIGURE Q3(a) : Retaining structure

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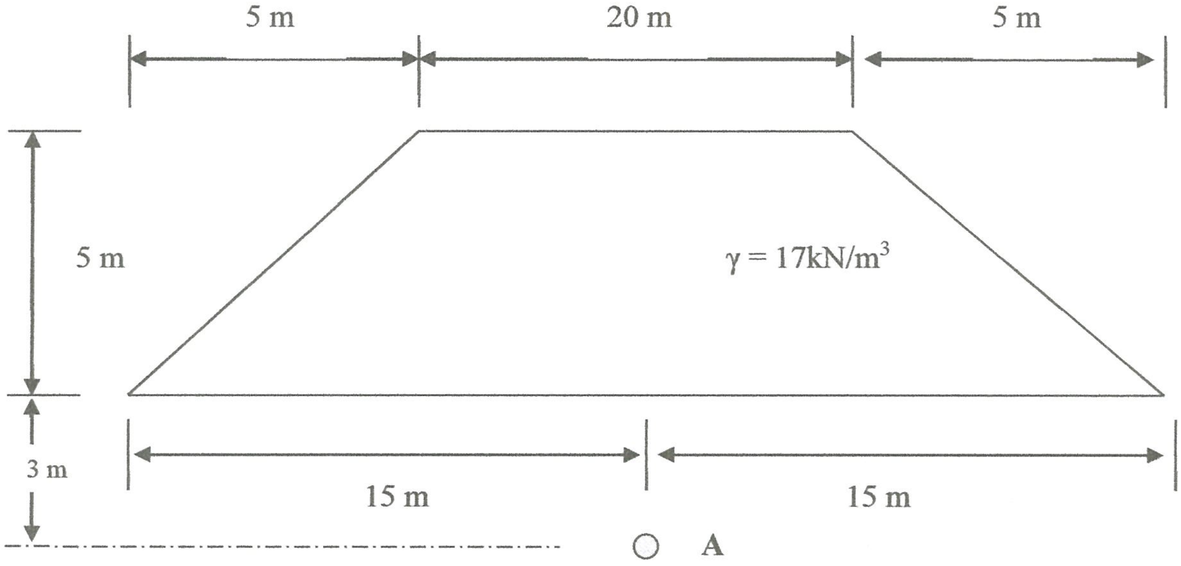
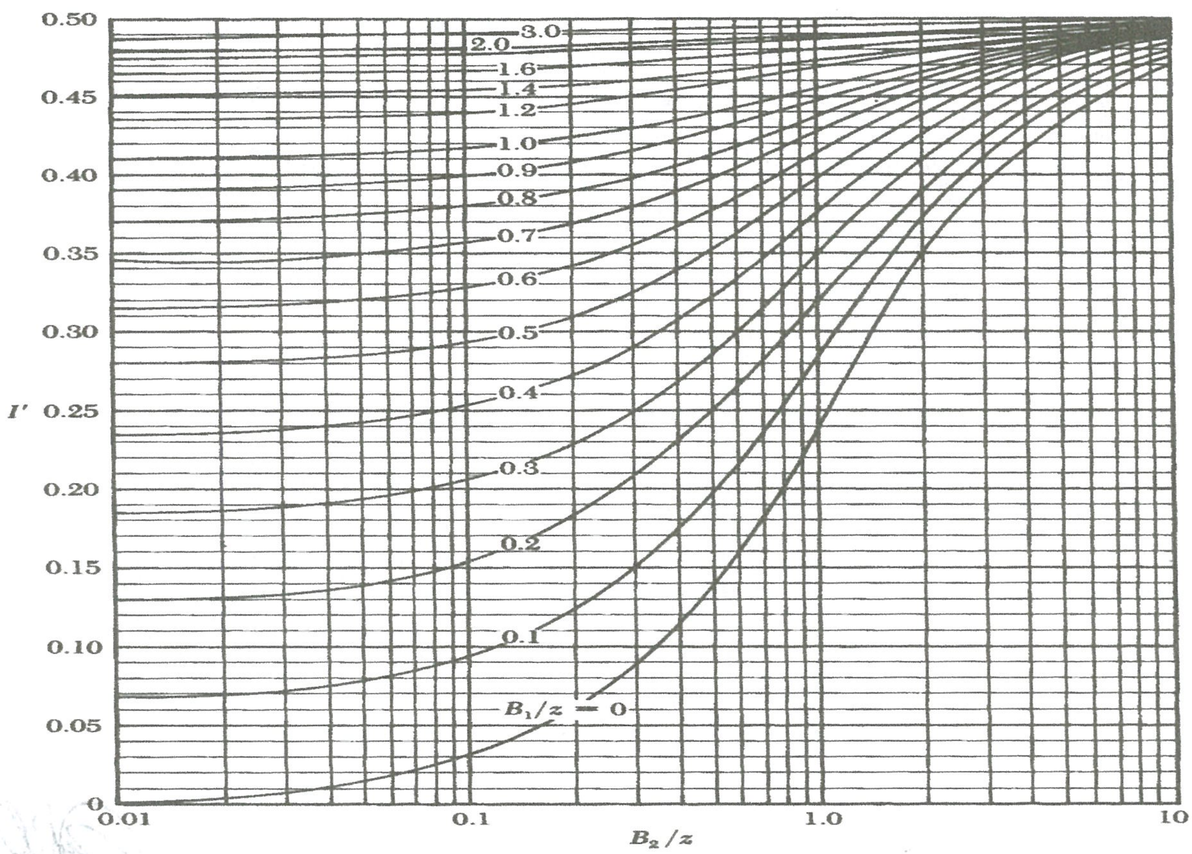


FIGURE Q3(b) : Embankment



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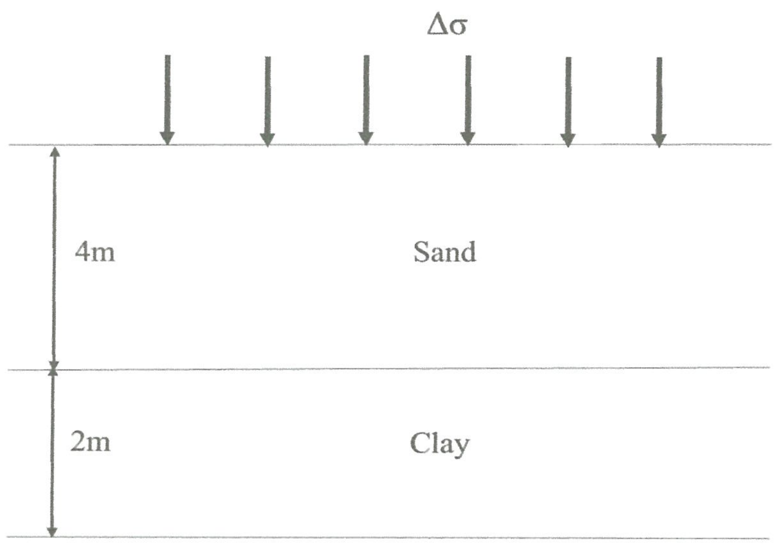

TABLE 2

Remarks	Pressure, σ' (kN/m^2)	Height, H (mm)
Loading	0	20.00
	25	19.92
	50	19.79
	100	19.50
	200	18.80
	400	18.00
	800	17.20
	1600	16.35
Unloading	800	16.55
	400	16.90
	200	17.20

FIGURE 4(b) : Soil layes

LIST OF FORMULAS

Flow in soil

$$q = k\,\frac{H N_f}{N_d} \text{ isotropic soil}$$

$$q = \sqrt{k_x k_z}\,\frac{H\,N_f}{N_d} \text{ Anisotropic soil}$$

$$i_{max} = \frac{\Delta h}{L}$$

Head loss of each potential drop, $\Delta h = \frac{\Delta H}{N_d}$

$$p_w = \frac{\Delta x}{3}\left[u_1 + u_n + 2u_{i(odd)} + 4u_{i(even)}\right]$$

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Stress in soil

Conventional retaining walls

Rankine active and passive pressure

$P_a = \frac{1}{2} K_a \gamma_1 H^2$ $\quad$ $P_a = \frac{1}{2} K_a \gamma_1 H^2 + qK_a H$

$P_v = P_a \sin \alpha°$ $\quad$ $P_h = P_a \cos \alpha°$

$P_p = \frac{1}{2} K_p \gamma_2 D^2 + 2c_2' \sqrt{K_p} D$

$K_a = \tan^2 (45° - \frac{1}{2}\phi_1')$ $\quad$ $K_p = \tan^2 (45° + \frac{1}{2}\phi_2')$

Factor of safety against overturning

$$FS = \frac{\Sigma W_i X_i}{\Sigma P_{a_i} z_{a_i}} = \frac{\Sigma (A_i \times \gamma_i) X_i}{\Sigma P_{a_i} z_{a_i}}$$

$$FS = \frac{\gamma_{n+i} A_{n+i} x_{n+i} + \ldots + \gamma_n A_n x_n}{P_a \cos \alpha (H'/3)}$$

Factor of safety against sliding

$$FS = \frac{\Sigma V \tan(\frac{2}{3}\phi_2') + \frac{2}{3} B c_2' + P_p}{P_a \cos \alpha}$$

$$z_o = \frac{2c_u}{\gamma}$$

Consolidation and settlement

$$\text{OCR} = \frac{\sigma_c'}{\sigma_o'}$$

$$S_p = H \frac{\Delta e}{1 + e_o}$$

$$S_p = \frac{C_c H}{1 + e_o} \log\left(\frac{\sigma_o' + \Delta\sigma'}{\sigma_o'}\right)$$

$$S_p = \frac{C_r H}{1 + e_o} \log\left(\frac{\sigma_o' + \Delta\sigma'}{\sigma_o'}\right)$$

$$S_p = \frac{C_r H}{1 + e_o} \log\left(\frac{\sigma_c'}{\sigma_o'}\right) + \frac{C_c H}{1 + e_o} \log\left(\frac{\sigma_o' + \Delta\sigma'}{\sigma_c'}\right)$$

$$T_v = \frac{c_v t}{H_{dr}^2}$$

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$$m_v = \frac{a_v}{1+e_{av}} = \frac{(\Delta e / \Delta\sigma')}{1+e_{av}}$$

$$T_v = \frac{\pi}{4}U^2{}_{avg} \qquad T_v = \frac{c_v t}{d^2} \qquad T_v = -\ 0.933 \log(1 - U_{avg}) - 0.085$$

$$U_z = 1 - \frac{u_e}{u_i} \qquad U_z = \frac{\Delta\sigma - u_e}{\Delta\sigma}$$

$$H_s = \frac{W_s}{AG_s\gamma_w} = \frac{M_s}{AG_s\rho_w}$$

$$e = \frac{H_v}{H_s}$$

$$C_c = \frac{e_1 - e_2}{Log\frac{\sigma'_2}{\sigma'_1}}$$

Slope stability

$$FS = \frac{c_n l_n + \sum_{n=1}^{n=p}(W_n cos\alpha_n - r_u sec\alpha_n)tan\phi_n'}{\sum_{n=1}^{n=p} W_n sin\alpha_n}$$

$$FS = \frac{\sum_{n=1}^{n=p}(c'R\theta + W_n cos\alpha_n tan\phi')}{\sum_{n=1}^{n=p} W_n sin\alpha_n}$$

$$FS = \frac{\sum C_u R^2\theta}{\sum M_d}, \theta \text{ in radian}$$

$$H = \frac{c'}{\gamma m}$$

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