



University Of Technology
Building and Construction Eng. Dept.
Final Exam 1st Attempt –2013/2014



Subject : Earth Structure
Branch : Road & Bridges Branch.
Examiner : Dr. Mahmoud R. M

Class: 4th Year
Time : 3 Hours
Date : 28/5/ 2014

Attempt 4 questions only

Q1- A- Discuss **five** of the following with figures:

- 1- Effect of lime additive on physical properties of clay.
- 2- Effect of increase in temperature on stability and expansion of soil stabilization with asphalt.
- 3- Effect of curing time of stabilized soil with cement in unconfined compression strength.
- 4- The effect of roller coverage's travel speed on amount of compaction with towed vibratory roller.
- 5- Effect of compaction on soil structure at the dry of optimum, at the optimum and at the wet of optimum.
- 6- The effect of number of roller passes on dry density at the field for 2 roller passes, 5 roller passes, 15 roller passes and 45 roller passes.

(15 Marks)

B- Discuss ~~the~~ mechanism **two** of the following stabilizing techniques:

- 1- Preloading for improving soft saturated soil.
- 2- Heavy tamping (Dynamic compaction) for improving layer of 12 m deep saturated silty sand.
- 3- Vibro flotation method for improving deep cohesion less soils.

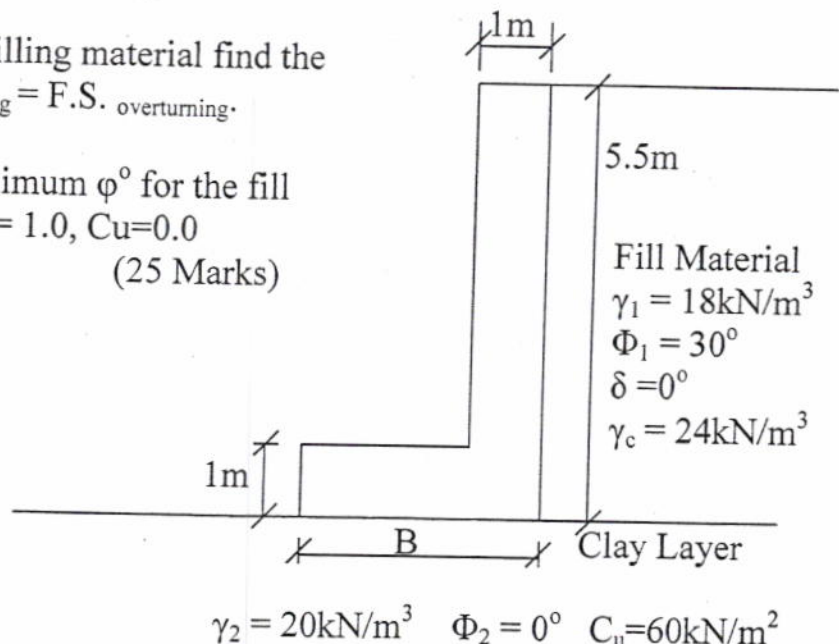
(10 Marks)

Q2- For the retaining wall shown in figure below :

a- If $\phi = 30^\circ$ for the filling material find the width (B) such that $F.S_{\text{sliding}} = F.S_{\text{overturning}}$.

b- If (B) = 4m, find minimum ϕ° for the fill material such that $F.S_{\text{sliding}} = 1.0$, $C_u = 0.0$

(25 Marks)



Q3- A half closed clay layer is 8.0m thick and it can be assumed that $c_v = c_h$. Vertical sand drains 300mm in diameter, spaced at 3m centers in a square pattern, are to be used to increase the rate of consolidation of the clay under the increased vertical stress due to the construction of an embankment. Without sand drains the degree of consolidation at the time the embankment is due to come into use has been calculated as 25%. What degree of consolidation would be reached with sand drains at the same time? (25 Marks)

Q4- A- An embankment has a slope of 1 vertical to 2 horizontal. The properties of the soil are: $C = 25 \text{ kN/m}^2$, $\phi = 20^\circ$, $\gamma = 16 \text{ kN/m}^3$, and $H = 37 \text{ m}$. Using Taylor's curves, determine the factor of safety F value for the slope. (15 mark)

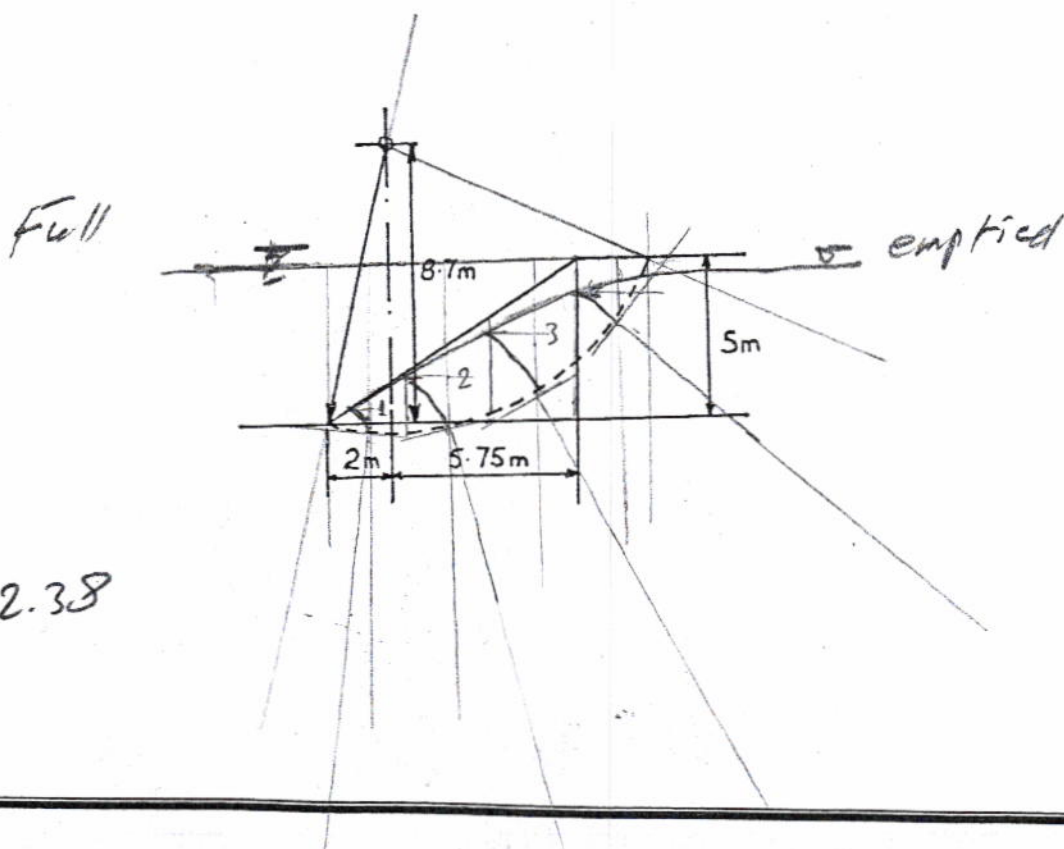
B- Show the main factors influence the choice of filter material and state the requirement which should be met for filter design criteria. (10 mark)

Q5- The cross section of the canal bank is shown in fig. Below. The properties of the soil are : $\gamma_{\text{sat}} = 20 \text{ kN/m}^3$, $c = 10 \text{ kN/m}^2$, $\phi = 15^\circ$. Using the trial slip circle shown and by dividing the sliding soil segment into four vertical slices, determine the f.s of the bank when :

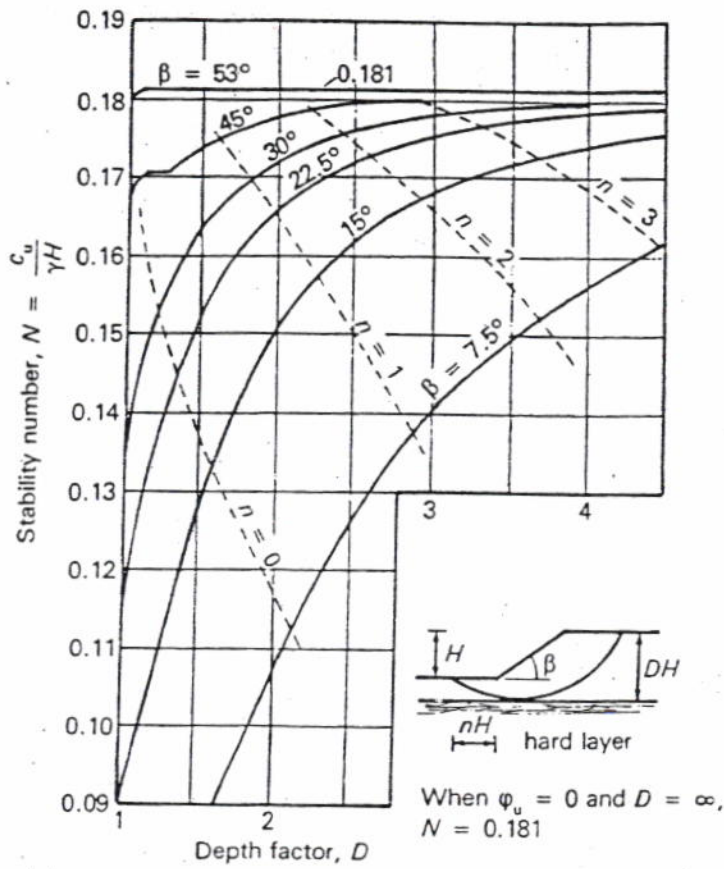
- 1-the canal is full to the top.
- 2-the canal is suddenly emptied

$$F = \frac{1}{\sum W \sin \alpha} \sum [c'l + W(\cos \alpha - r_u \sec \alpha) \tan \phi']$$

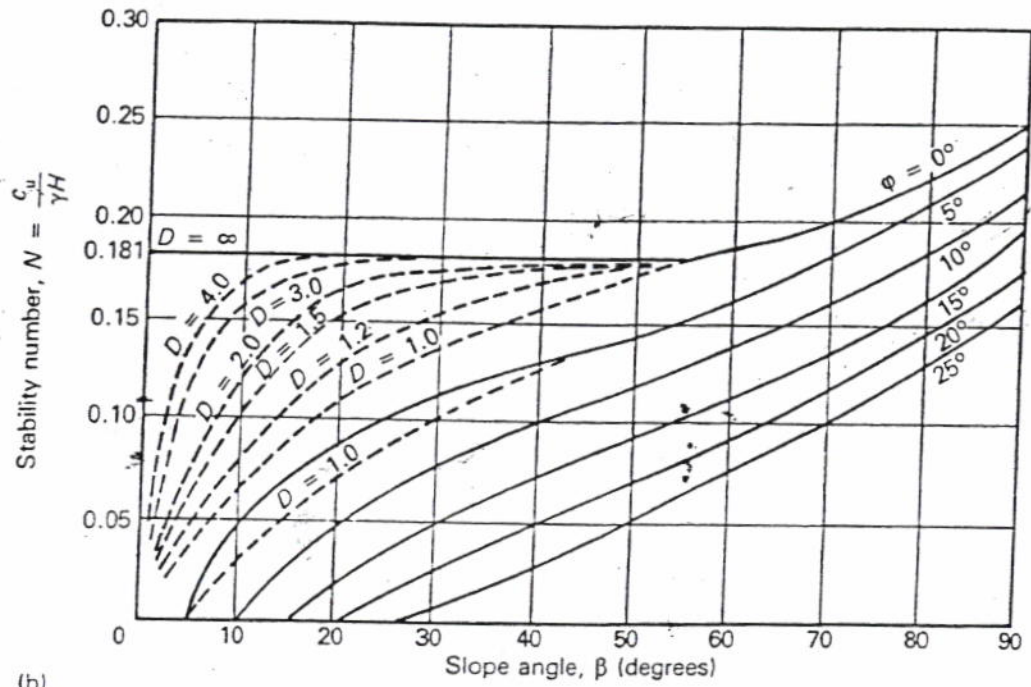
(25 mark)



$$S.F. = 2.38$$



(a)



(b)

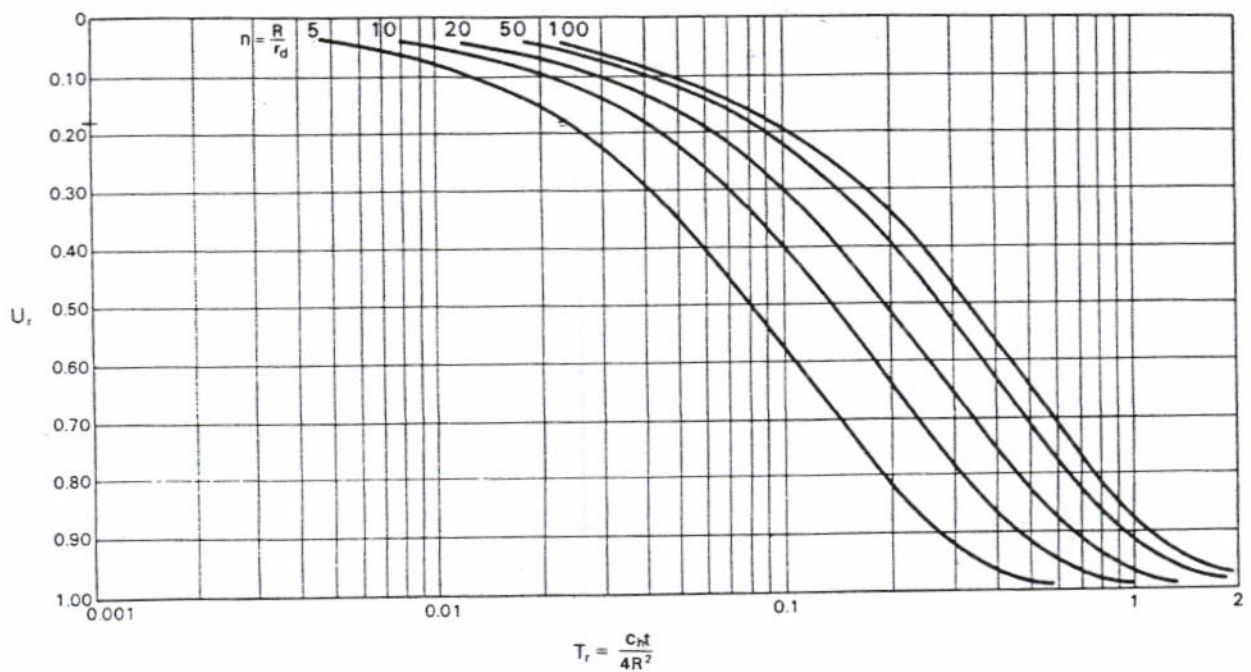


Fig. 7.30 Solution for radial consolidation.

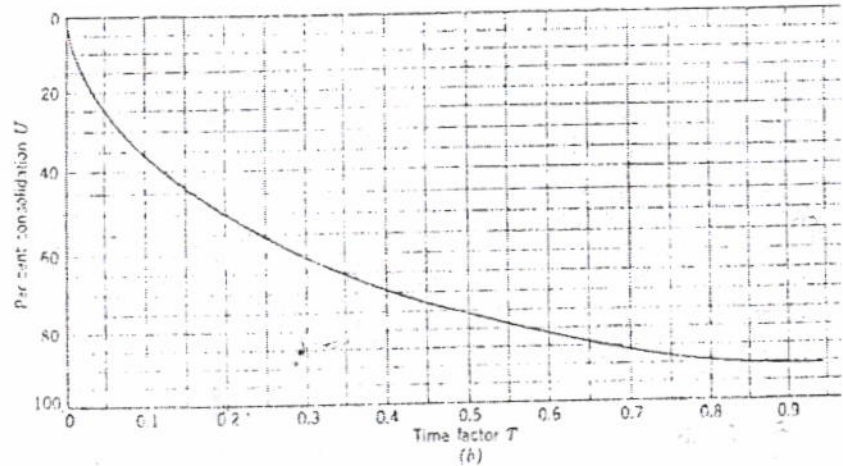
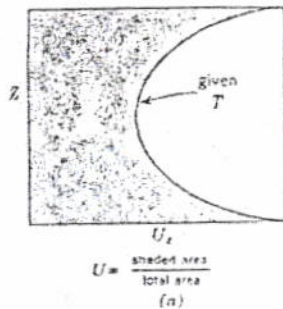


Fig. Average consolidation ratio: linear initial excess pore pressure. (a) Graphical interpretation of average consolidation ratio. (b) U versus T .

Given: $(1 - U_t) = (1 - U_v) * (1 - U_r)$

$$n = \frac{R}{r_d}$$

$$C_v = \frac{T_v d^2}{t}$$

$$C_h = \frac{T_r 4R^2}{t}$$

$$R = 0.564 S \text{ (square)}$$

$$R = 0.525 S \text{ (triangular)}$$

$$T_v = \frac{\pi}{4} (U_{av})^2 \text{ for } U_{av} < 60\%$$

$$S_{cf} = m_v * \Delta P' * H$$

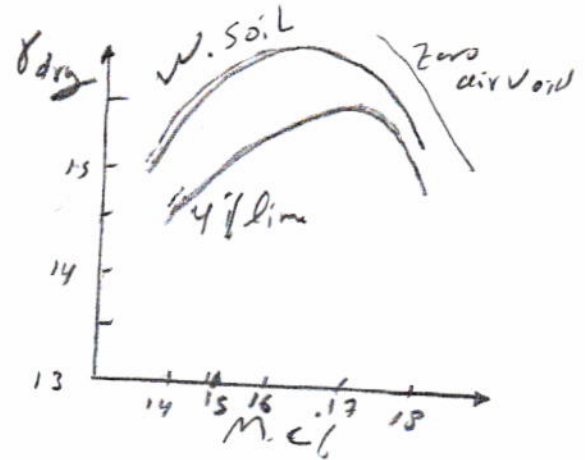
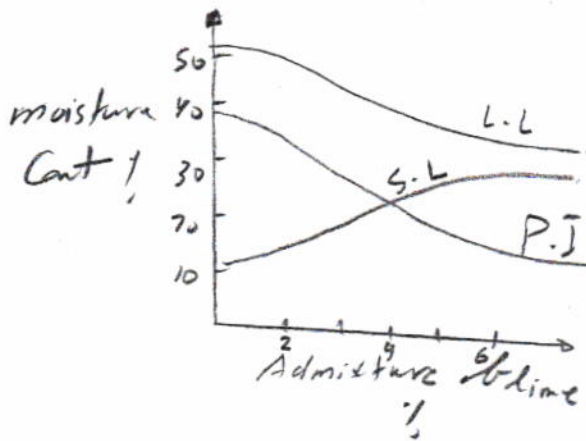
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Final Exam 1st Attempt

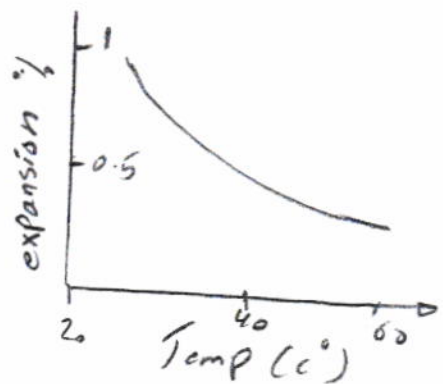
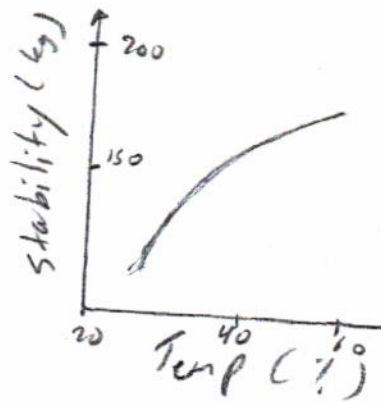
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Q. A.

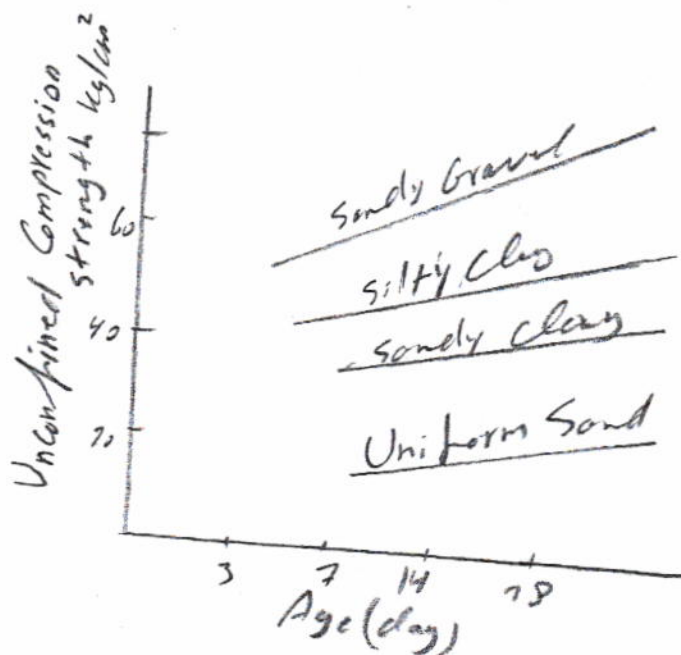
1-



2-



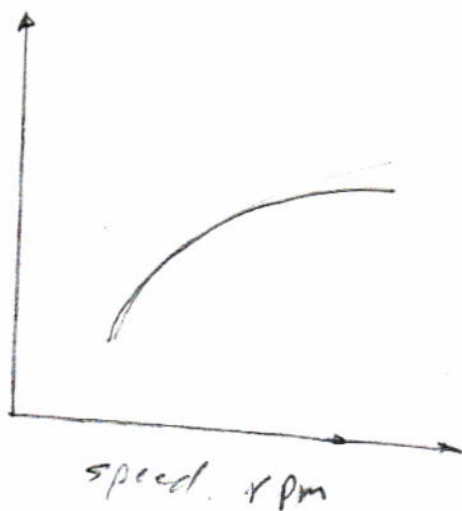
3-



4-

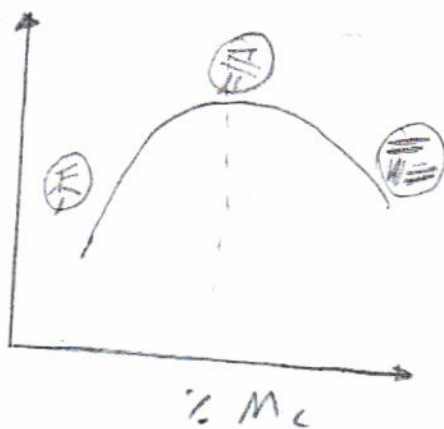
(2)

%
Compaction

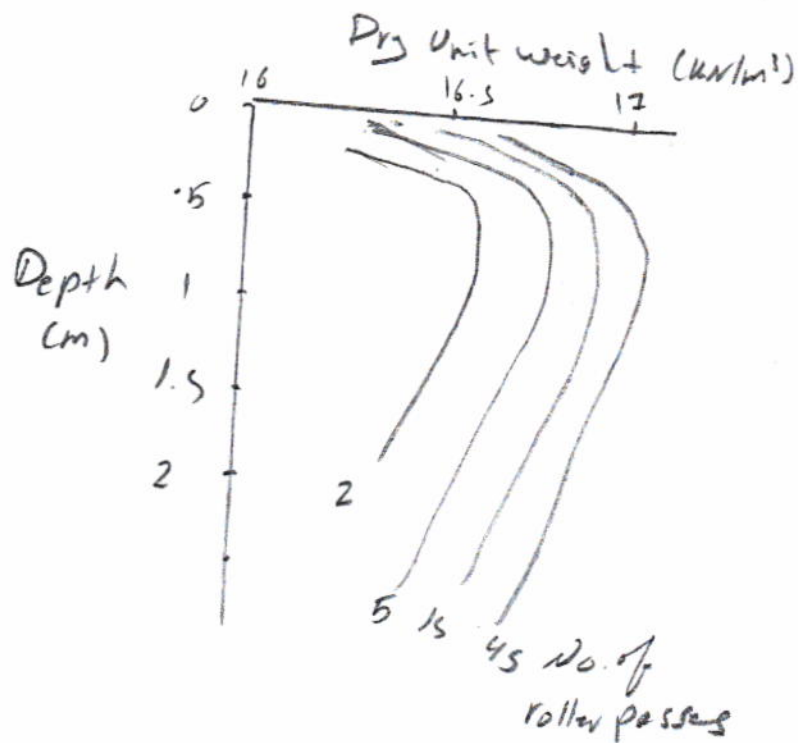


5-

γ_{dry}



6-



Q₁

B-1- Involves placement of a surface load. Prior to Construction in order to Compress the weak, very Compressible, foundation Soil. Then the Loading is removed and the structure is Constructed. The placement and removal of the Pre Loading will transform the soft foundation soil from N.C.C. to an O.C.C.

2- Consist in applying very heavy blows to the ground at short intervals with a rammer. Such blows being delivered by Free fall (10-40)m of rammer weighing several hundred kN's (400 kN). The soil improved obtained by heavy tamping can be observed.

3- Suspended vibrator From a jib of crane were used to densify of loose sand deposits. The vibrator section is located at lower end and is isolated from main body of the Unit. The unit penetrates the soil under its own weight, some times assisted by jet of water emitted from the Conical Point of the vibrator. Depth upto 12m can be penetrated

Q2

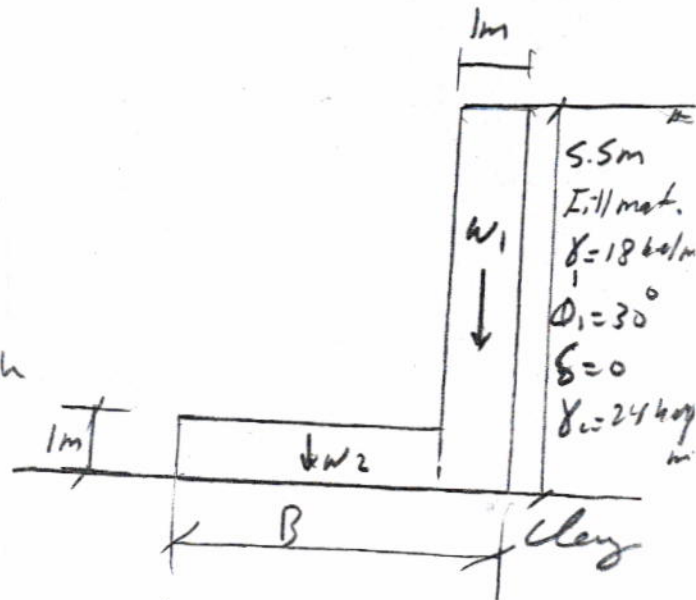
Q- For $\phi = 30^\circ$, $k_a = 0.33$, $k_p = 3.0$

$$P_a = 5.5 \times 18 \times 0.33 = 33 \text{ kN/m}$$

$$P_{aT} = 33 \times \frac{5.5}{2} = 90.75 \text{ kN/m length}$$

$$W_1 = 5.5 \times 1 \times 24 = 132 \text{ kN}$$

$$W_2 = (B-1) \times 1 \times 24 = (24B-24) \text{ kN}$$



$\gamma_2 = 20 \text{ kN/m}^3$, $\phi_2 = 0$, $c_u = 60 \text{ kPa}$

$$M_R = (132 \times (B-0.5)) + (24B-24)(B-1)/2$$

$$= 132B - 66 + 12B^2 - 24B + 12$$

$$= 12B^2 + 108B - 54$$

$$M_o = 90.75 \times \frac{5.5}{3} = 166.37 \text{ kN-m}$$

F.s sliding = F.s overturning

$$\frac{60 \times B \times 1 + \sum U \tan(0.67 \phi)}{90.75} = \frac{12B^2 + 108B - 54}{166.37}$$

$$110B = 12B^2 + 108B - 54$$

$$12B^2 - 2B - 54 = 0 \rightarrow B = 2.2 \text{ m}$$

$$b = 1 = \frac{0 + (132 + 72) \tan(0.67 \phi)}{90.75}$$

$$90.75 = 0 + 204 \tan(\underbrace{0.67 \phi}_\delta)$$

$$\tan \delta = \tan^{-1} 0.44 = 23.98^\circ$$

since $\delta = 0.67 \phi \rightarrow \phi = \frac{23.98}{0.67} = 35.79^\circ \approx 36^\circ$

Q3 - Without Sand drains:

$$U_v = 0.25$$

$$\therefore T_v = 0.049 \text{ From (Fig 1)}$$

$$\therefore t = \frac{T_v d^2}{C_v} = \frac{0.049 \times 8^2}{C_v}$$

- With Sand drains:

$$R = 0.5645 = 0.564 \times 3 = 1.69 \text{ m}$$

$$n = \frac{R}{r} = \frac{1.69}{0.15} = 11.3$$

$$T_r = \frac{C_h \cdot t}{4R^2} = \frac{C_h}{4 \times 1.69^2} \times \frac{0.049 \times 8^2}{C_v} \quad (C_h = C_v)$$

$$T_r = 0.275$$

$$U_r = 0.73 \text{ From (Fig 1)}$$

Using Eq.

$$\begin{aligned} (1-U) &= (1-U_v)(1-U_r) \\ &= (1-0.25)(1-0.73) = 0.2 \end{aligned}$$

$$\therefore U = 0.8$$

Q4

A- slope 1:2 $\rightarrow B = 26.5^\circ$

Try $F = 1.5$

$$\tan \phi_m = \frac{\tan \phi_u}{F} = \frac{0.364}{1.5} = 0.24$$

$$Q_m = 13.5 \rightarrow \text{From Fig } N = 0.05$$

$$\therefore F_c = \frac{25}{0.05 \times 16 \times 37} = 0.84$$

Try $F = 1.25$

$$\tan \phi_m = \frac{0.364}{1.25} = 0.291$$

$$Q_m = 16.2 \quad N = 0.035$$

$$F_c = \frac{25}{0.035 \times 16 \times 37} = 1.20 \quad \text{It is o.k.}$$

B- The main factors are:

- 1- The soil to be protected is not washed into the filter
- 2- Excessive hydrostatic pressure head is not created in the soil that has a lower coefficient of Permeability.

The Conditions are:

$$1- \frac{D_{15F}}{D_{85B}} < 5$$

$$3- \frac{D_{50F}}{D_{50B}} < 25$$

$$2- \frac{D_{15F}}{D_{15B}} > 4$$

$$4- \frac{D_{15F}}{D_{15B}} < 20.$$

Q5 1- Canal is Full to The top

slice	Z(m)	b(m)	W _{slice} (kN)	W _{water} (kN)	Total Weight W _T	r _u	α°	cos α	sin α	cos α - r _u sin α	W(cos α - r _u sin α) kN	sin α	W sin α
1	0.95	1.07	20.33	0.0	20.33	2.75	-6	.99	1.61	-1.78	-9.69	-.1	-2.03
2	2.38	1.07	50.93	9.5	60.43	0.95	13°	.97	1.03	0	0	0.22	13.29
3	3.21	1.07	68.69	26.1	94.79	0.48	28	.88	1.13	.33	8.38	.469	44.4
4	1.66	1.07	35.52	42.8	78.32	0.50	48	.66	1.51	-.09	-1.8	.743	58.1

Σ -3.11 Σ 113.85

The Calculation For The Conventional method are

$$\theta = 78^\circ, R = 9.0m$$

$$Cl' = CR\theta = 10 \times 9 \times 78 \times \frac{\pi}{180} = 122.46$$

$$\therefore F = \frac{122.46 - 3.11}{113.85} = 1.04$$

2- When The Canal is emptied.

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slice	Z (m)	b (m)	W (kN)	r_u	γ	$\cos \alpha$	$\sec \alpha$	$\cos \alpha - r_u \sec \alpha$	$W(\cos \alpha - r_u \sec \alpha) \tan \phi$	$\sin \phi$	$W \sin \alpha$
1	0.95	1.07	20.33	0.37	-6	0.99	1.01	0.616	3.35	-0.1	-2.03
2	2.38	1.07	50.93	0.35	13	0.97	1.03	0.609	8.31	0.22	13.29
3	3.21	1.07	68.69	0.29	28	0.88	1.13	0.552	10.15	0.469	44.4
4	1.66	1.07	35.5	0.28	48	0.66	1.51	0.23	2.18	0.743	58.1

$\Sigma 23.99$ $\Sigma 113.8$

$$\theta = 78^\circ, R = 9.0m$$

$$cl' = cR\theta = 10 \times 9 \times 78 \times \frac{\pi}{180} = 122.46$$

$$F = \frac{122.46 + 23.99}{113.8} = 1.28$$