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| **Kafrelsheikh University** | | **Full Mark : 75** |
| **Faculty Of Engineering** | | **Date : 20 / 1 / 2019** |
| **Civil engineering Dep.** | | **Time Allowed : 3 Hrs** |
| **Year : 3 rd Year Civil** | Soil Mechanic (2) | **Academic Number : CES3117** |

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**Attempt all questions, and any missing data can be assumed ( Note: exam in 5 papers)**

## QUEQUTION 1:

**1.A.1.** Derive an expression for the factor of safety of an infinite slope in a cohesionless soil. What is the effect of steady seepage parallel to the slope on the stability? **( 2 point)**

**1.A.2.** A long slope is to be constructed using a material with : $c = 0$ , $\phi = 35°$ , and $\gamma_{sat} = 20$ KN/m$^3$. Determine the critical slope angles ($\theta_c$) for both dry condition and steady state flow parallel to the surface. Calculate the factor of safety for both cases if $\theta = \theta_c / 1.5$. **(2 point)**

**1.B.1.** A soil mass is resting on an inclined impermeable clay layer as shown in Fig.(1). Determine the factor of safety against wedge failure along the interface. The soil has $c = 6$ KN/m$^2$, $\phi = 20°$, $\gamma = 17$ KN/m$^3$ . **( 2 point)**

**1.B.2.** An unsupported slope is shown in Fig.(2). Determine the factor of safety against sliding for the trial slip surface. Take $c = 50$ KN/m$^2$, and $\phi = 0$. The weight of the wedge ABD is 2518 KN and acts at a horizontal distance of 11 m from the vertical AO. **(4 point)**

**1.C.** A square footing ( 1.5 m × 1.5 m ) is located at a depth of 1.0 m. The footing is subjected to an eccentric load of 400 KN , with an eccentricity of 0.20 m along one of the symmetrical axes . Determine the factor of safety against bearing failure. Use Egypt code equation , take $N_c = 5.14$ , $N_q = 1.00$ and $N_\gamma = 0.0$ **(5 point)**

## QUEQUTION 2:

**2.A.** A cantilever sheet pile as shown in Figure (3) supports a 9 m high backfill with the following properties :

Soil 1 : $c = 0$ , $\phi = 35°$ , $\gamma = 18$ KN/m$^3$

Soil 2: $c = 15$ kPa , $\phi = 20°$ , $\gamma_{sat} = 20.3$ KN/m$^3$

Soil 3: $c = 0$ , $\phi = 35°$ , $\gamma_{sat} = 21.1$ KN/m$^3$

Soil 4 : $c = 100$ kPa , $\phi = 0$ **in both sides**

There is a vertical surface load of 20 kPa applied at the backfill. The water table is 3 m below the ground surface of the backfill and has the same level at the front of the sheet pile .

Determine the embedment depth D assuming that the full passive resistance is mobilized, take F.O.S = 1.5. **( 7 point)**

**2.B.** A concrete gravity retaining wall is 6.6 m high and 3.2 m wide. If the thickness of the soil at the front of the wall is 2 m , determine the maximum and the minimum base pressures , and determine the factor of safety of sliding. The soil has the following properties :

$c = 0$ , $\phi = 35°$ , $\gamma_{soil} = 1.8$ Mg/m$^3$ , $\gamma_{concrete} = 2.4$ Mg/m$^3$ **( 5 point)**

**2.C.** A cylindrical specimen of 10 cm diameter and 20 cm length was prepared by compaction in a mould. If the wet mass of the specimen was 3.25 kg and its water content was 15 % , determine the dry density and the void ratio. If the specific gravity of the particles was 2.70 , find the degree of saturation . **( 3 point)**

## QUEQUTION 3:

**3.A.** An earthen embankment of $10^6$ $m^3$ volume is to be constructed with a soil having a void ratio of 0.80 after compaction. There are three borrow pits marked A,B and C having soils with void ratios 0.90, 1.50 and 1.80, respectively. The cost of excavation and transporting the soil is 25, 23 and 18 pounds per $m^3$ respectively. Calculate the volume of soil to be excavated from each pit. Which borrow bit is the most economical ? ( Gs = 2.65 ). (5 point)

**3.B.** Two footing A & B both has rectangular section in plan ( 2m × 6m ). They carry same load at their foundation level ( 2.2 m blow the ground surface ), which is 264 tons including their own weight. Show by calculation which of the two footing is more safe than the other by using Egyptian code equation :-

Footing A : Soil is saturated clay ( c = 0.60 Kg/cm$^2$ , $\phi$ = 0.0 , $\gamma$ = 1.85 t/m$^3$ ) ground water table is far below foundation level. ( Take $N_c$ = 5 , $N_q$ = 1.0, and $N_\gamma$ = 0.0 at $\phi$ = 0.0)

Footing B : Soil is sand ( c = 0. 0 Kg/cm$^2$ , $\phi$ = 30° , $\gamma$ = 1.60 t/m$^3$ ) ground water table is far below foundation level. ( Take $N_c$ =30 , $N_q$ =18, and $N_\gamma$=10 at $\phi$ = 30 ). **( 5 point)**

**3.C.** Determine the allowable gross load and the net allowable load for a square footing of 2 m side and with a depth of foundation of 1 m. Use Terzaghi's theory and assume local shear failure. Take a factor of safety of 3.0. The soil at the site has : c = 15 KN/m$^2$ , $\phi$ = 25 ° $\gamma$ = 18 KN/m$^3$ ( take $N_c$ = 14.8 , $N_q$ = 5.6 and $N_\gamma$ = 3.2 for local shear failure ) for the following :

(a) The water table rises to the level of the base.

(b) The water table rises to the ground surface.

(c) The water table is 1 m below the base. **( 5 point)**

## QUEQUTION 4:

**4.A.** A retaining wall 10.00 m high , the soil behind the wall of density 1.9 t/m$^3$, with level surface. The active thrust on the wall is 20 tons per meter length of the wall. Height of the wall is to be increased , and to keep the forces on the wall within allowable limits, the soil behind the wall is removed to a depth of 5m. and replaced by fill of density 0.90 t/m$^3$ and the same friction angle as that of soil. **What additional height** may be allowed if it is required that the active thrust on the wall be limited to its initial value . **( 5 point)**

**4.B.** The concrete gravity retaining wall shown in Fig.4 supports two layers of soil each having a thickness of 3 m . The properties of the layers are :
Upper layer : c = 0 , $\phi$ = 30 ° , $\gamma_{dry}$ = 17.5 KN/m$^3$ , $\gamma_{sat}$ = 19.5 KN/m$^3$ ;
Lower layer : c = 10 kPa , $\phi$ = 18 ° , $\gamma_{sat}$ = 19 KN/m$^3$ . There is a surface load of 50 kPa and the water table is 1.5 m below the ground surface . The front of the wall is supported by soil with c = 20 kPa, $\phi$ = 25 °, $\gamma$ = 18 KN/m$^3$ . Determine :
(a) The factor of safety against sliding assuming that the cohesion between the base of the wall and the soil is 20 KPa , and the mobilized friction angle on this interface is 25°.
(b) The factor of safety against overturning .
(c) The distribution of the contact pressure under the base of the wall
Take the unit weight of the concrete as 24 KN/m$^3$. Assume the back and front faces of the wall are smooth. **( 5 point)**

**4.C.** A square column foundation is to be designed for a gross allowable total load of 250 KN. If the load is inclined at an angle of 15 ° to the vertical, determine the width of the foundation. Take the factor of safety of 3.0 and use Hansen's equation c = 5 KN/m$^2$ , $\phi$ = 35 ° , $\gamma$ = 19 KN/m$^3$. The depth of foundation is 1.0 m.
Take $N_c$ = 46.12 , $N_q$ = 33.30 and $N_\gamma$ = 48 **(5 point)**

**<u>QUEQUTION 5:</u>**

**5.A.** A footing load test was carried out on a square steel plate 75cm width at ground surface, where the ultimate load on the steel plate was 30t. A layer of sand soil ($\phi$=30 ° , $\gamma_{sat}$ =1.8t/m$^3$) is extend from ground surface till depth 15m. The ground water table was below ground surface by 2m. **<u>Calculate the allowable load</u>** which a square footing with 3m width will carry if the foundation depth is 1.5m in the same site, use F. O. S = 3. (take **( 5 point)** = 30 , $N_q$ = 18 and $N_\gamma$ = 10).

a. Using the result of field test.
b. Using Egyptian Code for shallow bearing capacity . **( 5 point)**

**5.B.** Draw in details without calculation the minimums main steel only for the Retaining walls as shown in Fig. (5a,b, c, d, e). **( 5 point)**

**5.c.** Draw the distribution stress in plains under rectangular footings (L*B m) for the following cases:

**1.** $e_L/L < 1/6$ & $e_B/B < 1/6$
**2.** $e_L/L < 1/6$ & $0 < e_B/B < 0.5$
**3.** $e_L/L < 0.5$ & $0 < e_B/B < 1/6$
**4.** $e_L/L > 1/6$ & $e_B/B > 1/6$ **( 5 point)**

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Soil Mechanic (2)

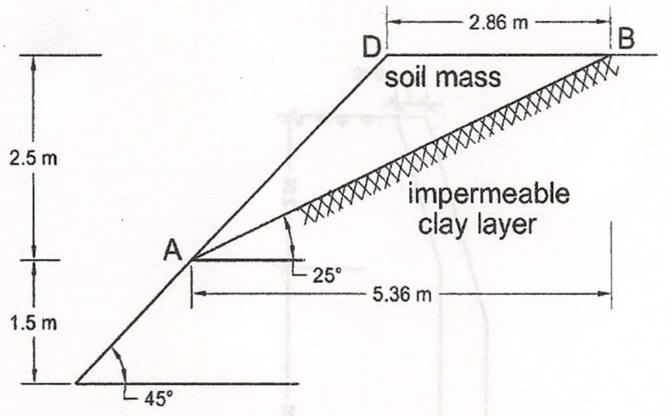


Fig.1

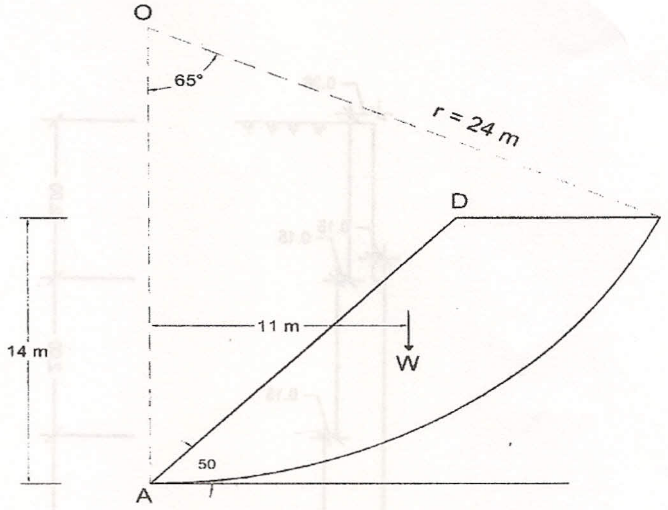


Fig.2

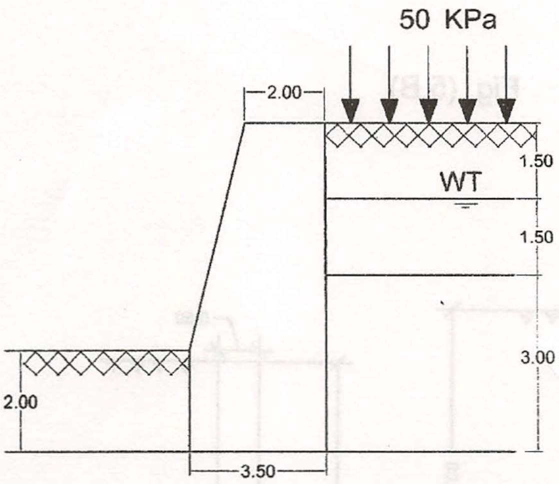


Fig.4

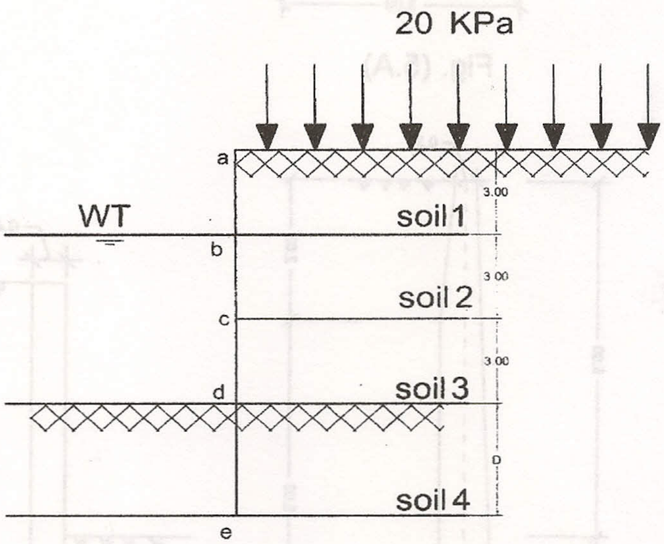


Fig.3

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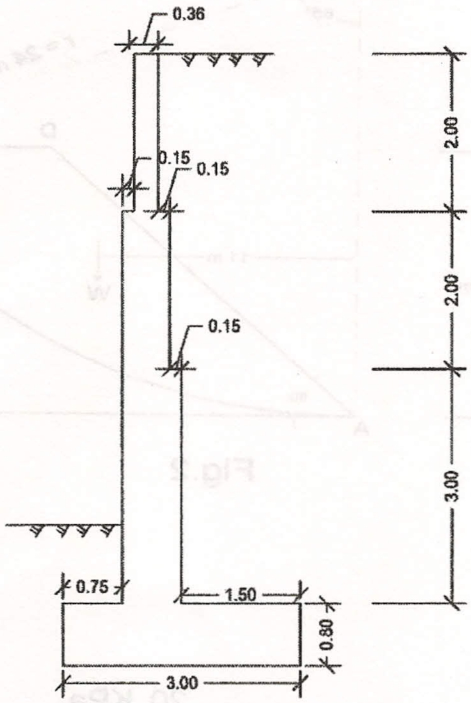


Fig. (5.A)

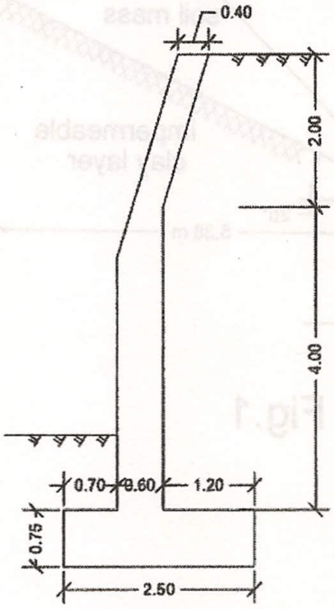


Fig. (5.B)

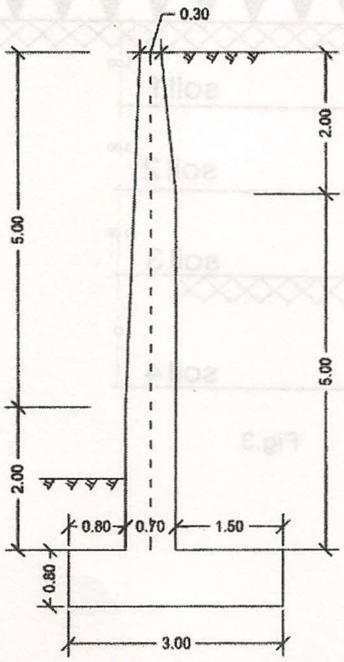


Fig. (5.C)

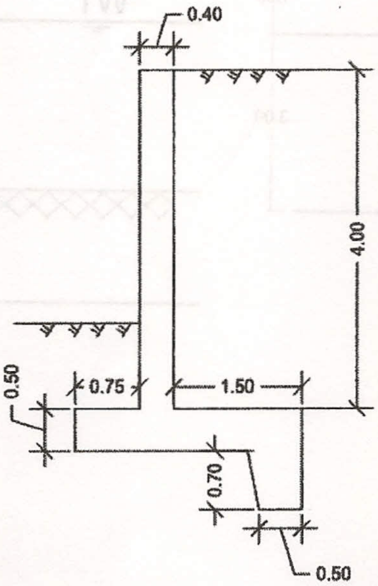


Fig. (5.D)

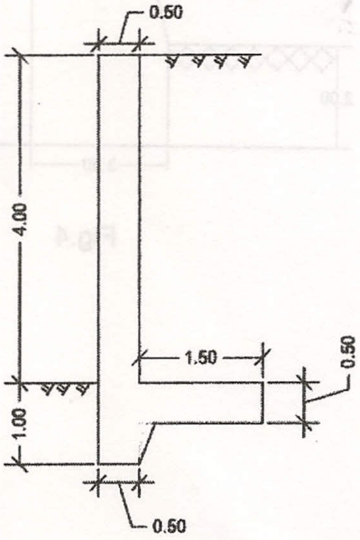


Fig. (5.E)