2019

# CIVIL ENGINEERING
## PAPER-I

*Time Allowed—3 Hours* *Full Marks—200*

*If the questions attempted are in excess of the prescribed number, only the questions attempted first up to the prescribed number shall be valued and remaining ones ignored.*

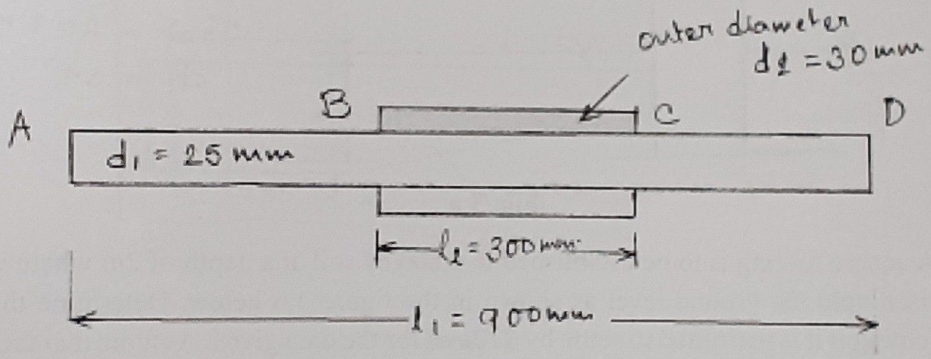
*The figures in the margin indicate marks for each question.*

## Group-A

Answer *any four* questions.

**1.** (a) A 25mm diameter steel rod of length $l_1 = 900$ mm has a bronze sleeve of external diameter 30 mm and of length $l_2 = 300$ mm. The sleeve is shrunk on that rod so that the two components are securely bonded as shown in figure 1.a below. Find the total elongation of the steel rod due to a rise in temperature of 200°C.

Take, $E_s = 2 \times 10^5 N/mm^2$, $E_b = 1 \times 10^5 N/mm^2$, $\alpha_s = 1{\cdot}2 \times 10^{-5}$ per °C, $\alpha_b = 2{\cdot}03 \times 10^{-5}$ per °C. 15




(b) Draw shear force and bending moment diagram for the beam shown below in figure 1.b. 20

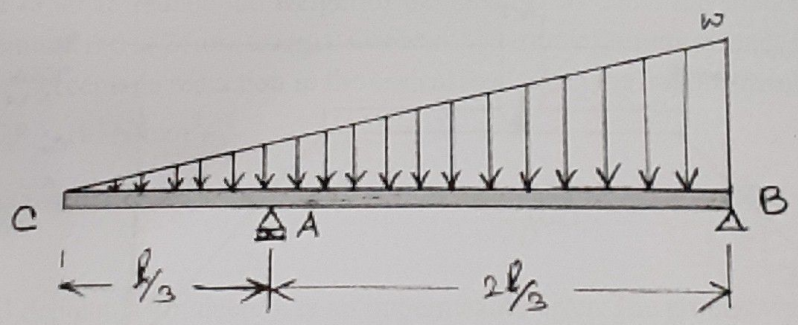



Fig. 1. b

2. (a) A layer of clay of thickness 12·5 m is underlian by sand. The saturated unit weight of the clay is 18·5 KN/m$^3$. When the depth of an open trench excavated in the clay reached a depth of 8m the bottom cracked and the water started entering the trench below. Determine the height to which water would have risen from the top of sand in the bore hole if it were drilled into sand prior-to the excavation.

Take, $\gamma_w = 10\,KN/m^3$ 10

(b) In the laboratory test on a clay sample of thickness 25 mm drained at top only, 50% consolidation occured in 11 minutes. Find the time required for the corresponding clay layer in the field 3m thick and drained at top and bottom, to undergo 70% consolidation.

Assume $T_{50} = 0{\cdot}197$, $T_{70} = 0{\cdot}405$. 25

3. (a) Plot (not to scale) the active earth pressure distribution on the retaining wall shown in figure 3.a, by Rankine's theory, for the data given.

Take, $\gamma_w = 10\,KN/m^3$ 15

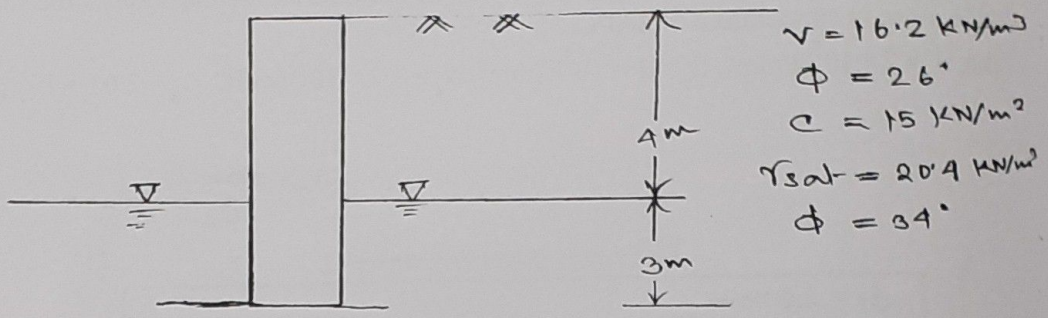



Fig. 3.a

(b) A square footing is to be established in a clayey soil at a depth of 2m where water table has risen upto the ground level as shown in the figure 3.b below. Determine the width of the footing if it is permitted to settle by 120mm for the data given. Assume that the net load given is a constant and that the same is dispersed into clay.

Take, $\gamma_w = 10\,N/m^3$ 20

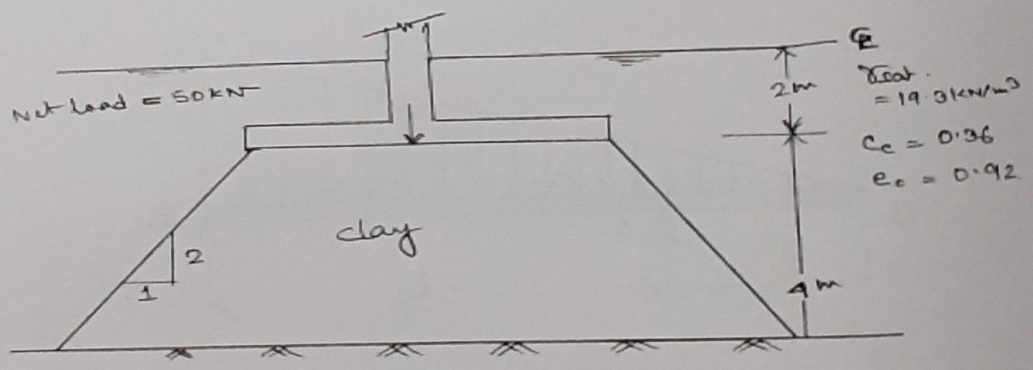



Fig. 3.b

4. (a) Using Terzaghi theory determine the ultimate bearing capacity of a strip footing 1·5m wide resting on a saturated clay ($C_u = 30\ kN/m^2$, $\phi_u = 0$, $\gamma_{sat} = 20\ kN/m^3$), at a depth of 2m below ground level. The water table is also at a depth of 2m from the ground level. If the water table rises by 1m, calculate the percentage reduction in the ultimate bearing capacity. 10

(b) An anchored sheet pile wall is to retain soil to a height of 5·5m. The soil including that into which the pile is driven, is cohesionless with $\phi = 30°$ and $r_b = 20·8\ kN/m^3$. The surface of the retained soil is horizontal and level with top of the wall. Tie rods are fixed at 1·83m below the top of the wall. Determine the minimum penetration depth of the pile to achieve free earth support condition. 25

5. (a) A cohesionless soil with a void ratio of e = 0·6 and specific gravity of soil solids, $G_s = 2·65$ exists at a site where the water table is located at a depth of 2 meters below the ground surface. Assuming a value of coefficient of earth pressure at rest, $K_0 = 0·5$. Calculate the following quantities at a depth of 5 metres below the ground surface, total stresses $\sigma_V$ and $\sigma_H$, effective stresses, $\sigma_V'$ and $\sigma_H'$ and pore water pressure U. Assume soil to be dry above the water table and saturated below the water table. Use $r_w = 9·81\ kN/m^3$. 18

(b) Compute the size of fillet weld for a bracket connection with ISMB 300 column as shown in figure 5.b below. Permissible shear stress in weld = 110MPa. 17

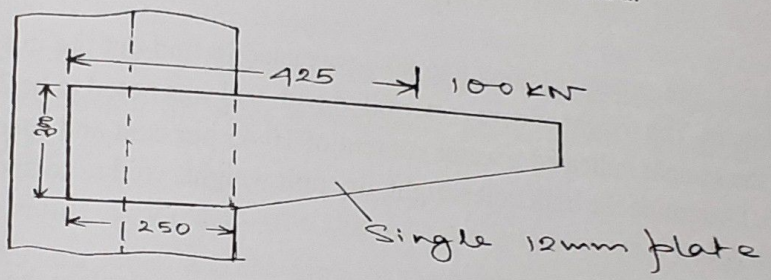



Fig. 5.b

## Group-B

Answer *any four* questions.

6. A compression member of 500mm effective length consists of a solid aluminium rod of 25mm diameter. In order to reduce the weight of the member by 25%, the solid rod is replaced by a hollow aluminium rod of 25mm external diameter. Determine the critical loads for the two members. Find also the percentage reduction in the critical load when the hollow member is provided. Take $E = 7·28 \times 10^4\ N/mm^2$. 15

7. Design a rectangular beam section subjected to a moment of 80kN–m. Take M20 mix & Fe 415 grade steel. 15

8. Granular soil deposit is 7m deep over an impermeable layer. The ground water table is 4m below the ground surface. The deposit has a zone of capillary rise of 1·2 m, with a saturation of 50%, plot the variation of total stress, pore water pressure and effective stress with the depth of deposit given for the granular soil e = 0·6 and G = 2·65. 15

9. Using free earth support method, calculate the depth of embendment of the sheet pile and the pu in the anchor rod for the anchored bulkhead system shown in Fig. 9 below.

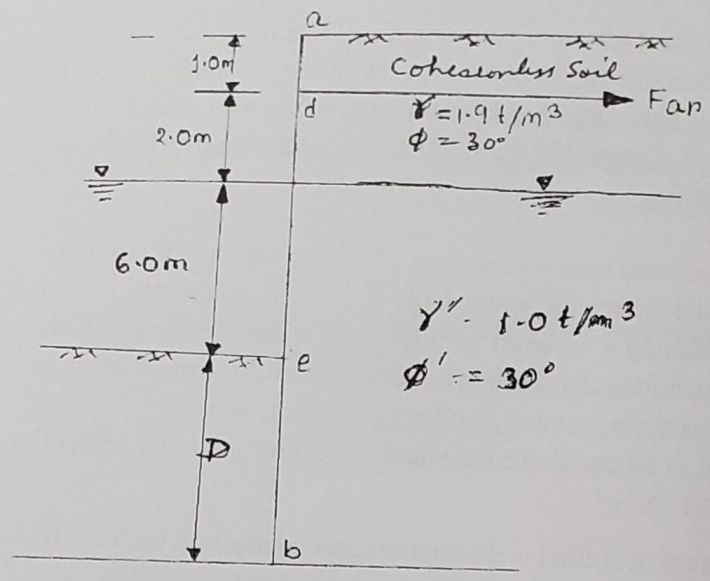



Fig. 9

10. (a) A 1000 CC core cutter weighing 946·80 g was used to find out the in situ unit weight of an embankment. The weight of core cutter filled with soil was noted to be 2770·60g. Laboratory test on the sample indicated a water content of 10·45 per cent and specific gravity of solids of 2·65. Determine the bulk unit weight, dry unit weight, void ratio and degree of saturation of the sample.

If the embankment becomes saturated due to rains, calculate the water content and the saturated unit weight. (Assume there is no volume change in sample on saturation.) 8

(b) The undisturbed soil at a borrow pit has a water content of 15 per cent. Void ratio of 0·60 and specific gravity of solids 2·70. The soil from the borrow pit is to be used for construction of an embankment with a finished volume of 40,000 Cu.m. The specifications for the embankment require a water content of 18 per cent and dry unit weight of 1·76 gm/cc. Calculate the quantity of soil required to be excavated for the embankment. 7