CLASS TEST

S.No.: 01DLSK_CE_DEFGH_300426

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SOIL MECHANICS

CIVIL ENGINEERING

Date of Test : 30/04/2026

ANSWER KEY

1.	(b)	7.	(b)	13.	(b)	19.	(b)	25.	(c)
2.	(b)	8.	(d)	14.	(a)	20.	(b)	26.	(a)
3.	(d)	9.	(c)	15.	(a)	21.	(c)	27.	(c)
4.	(d)	10.	(d)	16.	(c)	22.	(c)	28.	(b)
5.	(a)	11.	(d)	17.	(b)	23.	(a)	29.	(c)
6.	(d)	12.	(d)	18.	(b)	24.	(d)	30.	(b)

DETAILED EXPLANATIONS

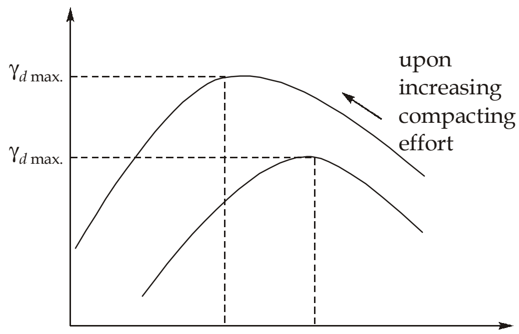
1. (b)

$$\text{Activity, } A_t = \frac{I_p}{\%\text{ finer than } 2\mu} = \frac{w_L - w_p}{\%\text{finer than } 2\mu}$$

$$= \frac{52 - 35}{20} = 0.85$$

This contains illite mineral as activity lies between (0.5 to 1.0).

2. (b)



3. (d)

Given:

$$w_L = 56\%$$
$$w_p = 39\%$$
$$\text{Plasticity index, } I_p = w_L - w_p$$
$$= 56 - 39 = 17\%$$
$$I_p \text{ of A line} = 0.73[w_L - 20]$$
$$= 0.73[56 - 20] = 26.28 > I_p \text{ of soil}$$

∴ Soil is silt (M).

Also, $w_L > 50$, therefore soil is highly compressible.

4. (d)

For remoulded soil,

$$C_c = 0.007(w_L - 7)$$
$$\Rightarrow \quad C_c = 0.007(47 - 7) = 0.28$$

5. (a)

Seepage velocity is given as,

$$V_s = \frac{\text{Discharge velocity (V)}}{\text{Porosity } (n)}$$

$$\Rightarrow \quad \frac{V_s}{V} = \frac{1}{n}$$

$$\Rightarrow \quad 2.7 = \frac{1}{n}$$

$$\Rightarrow \quad n = 0.37$$

Now,

$$n = \frac{e}{1+e}$$

$$\therefore \quad 0.37 = \frac{e}{1+e}$$

$$\Rightarrow \quad e = 0.59$$

6. (d)

7. (b)

$$\text{Sensitivity } (s) = \frac{C_u(\text{Undisturbed})}{C_u(\text{remoulded})}$$

Here,
$$C_u = \frac{T}{\pi d^2\left(\frac{h}{2}+\frac{d}{6}\right)}$$

$$\therefore \quad C_u \propto T$$

$$\Rightarrow \quad S = \frac{T(\text{Undisturbed})}{T(\text{remoulded})} = \frac{36}{6} = 6$$

8. (d)

$$K_0 = \frac{\mu}{1-\mu} = \frac{0.28}{1-0.28} = 0.39$$

9. (c)

Degree of swelling	DFS, percent
Low	less than 20
Moderate	20 - 35
High	35 - 50
Very high	> 50

10. (d)

As per IS Code, the inside clearance for sand, silts and clays should be 0.5%. For stiff and hard clays (below water table) it should be 1.5% and for stiff expansive clay it should be 3%.

11. (d)

12. (d)

Given:
W = Weight of hammer = 3 tonne $\simeq$ 30 kN
Q_{ap} = 25 tonne $\simeq$ 250 kN
FOS = 6 [For Engineering News Record formula]
C = Combined temporary correction i.e. 0.25 cm for steam hammer
H = Height of fall = 100 cm

$$\text{Ultimate load, } Q_{up} = \frac{WH}{S+C}$$

$$\text{Allowable load, } Q_{ap} = \frac{WH}{(S+C)FOS}$$

$$\Rightarrow \quad 250 = \frac{30 \times 100}{(S+0.25)\times 6}$$

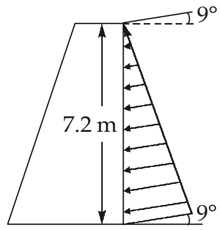
$$\Rightarrow \quad S = 1.75 \text{ cm}$$

Now, net value of settlement per 10 blows will be,

$$S = 1.75 \times 10 = 17.5 \text{ cm}$$

13. **(b)**

14. **(a)**



According to Rankine's theory,

$$K_a = \cos\beta\left(\frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi}}\right)$$

$$= \cos 9°\left(\frac{\cos 9° - \sqrt{\cos^2 9° - \cos^2 27°}}{\cos 9° + \sqrt{\cos^2 9° - \cos^2 27°}}\right)$$

$$= 0.988 \times 0.397 = 0.392$$

Total active thrust per meter run of the wall is,

$$P_a = \frac{1}{2}\gamma H^2 K_a = \frac{1}{2} \times 20 \times 7.2^2 \times 0.392$$

$$= 203.2 \text{ kN/m}$$

15. **(a)**

Factor of safety, $\text{F.O.S.} = \left(1 - \frac{\gamma_w}{\gamma_{avg}}\frac{h}{z}\right)\frac{\tan\phi}{\tan i}$

$$\gamma_{avg} = \frac{20 \times 4 + 16 \times 6}{10} = 17.6 \text{ kN/m}^3$$

$$\therefore \quad \text{FOS} = \left(1 - \frac{9.81}{17.6} \times \frac{4}{10}\right)\frac{\tan 45°}{\tan 35°} = 1.11$$

16. **(c)**

Observed value of N = No. of blows for the last 300 mm penetration

$$= 15 + 25 = 40$$

(i) Correction for overburden:

$$N' = N\left(\frac{350}{\bar{\sigma} + 70}\right)$$

Here, $\bar{\sigma} = 5 \times 17.5 + (20) \times (17.5 - 9.81) = 241.3$ KPa

$$\therefore \quad N' = 40\left(\frac{350}{241.3 + 70}\right) = 44.97$$

(ii) Dilatancy correction:

$$N'' = 15 + \frac{1}{2}(N' - 15)$$

$$= 15 + \frac{1}{2}(44.97 - 15) = 29.985 \approx 29$$

17. (b)

Stability number, $S_n = \dfrac{C}{\gamma \cdot H \cdot FOS}$

Here FOS = 1

C = 72 kPa

S_n = 0.047

When water table is at ground level,

$\gamma = \gamma_{sub} = 17.5 - 9.81 = 7.69 \text{ kN/m}^3$

$\therefore \quad 0.047 = \dfrac{32}{7.69 \times H_1}$

$\Rightarrow \quad H_1 = 88.54$ m

After sudden drawdown,

$\gamma = \gamma_{sat} = 17.5 \text{ kN/m}^3$

$\therefore \quad 0.06 = \dfrac{32}{17.50 \times H_2}$

[$\because$ S_n will be corresponding to reduced friction angle]

$\Rightarrow \quad H_2 = 30.48$ m

Difference between height $= H_1 - H_2 = 88.54 - 30.48$

$= 58.06$ m

18. (b)

Equivalent coefficient of permeability, when flow is taking place perpendicular to bedding plane, is given as;

$$k_{eq.} = \frac{\Sigma H_i}{\Sigma \dfrac{H_i}{k_i}}$$

$$= \frac{80 + 100 + 120}{\dfrac{80}{2 \times 10^{-2}} + \dfrac{100}{2.5 \times 10^{-2}} + \dfrac{120}{5.5 \times 10^{-3}}}$$

$= 0.01$ m/s

$q = k_{eq.}\, i.\, A = k_R \,.\, i_R \cdot A$

$\Rightarrow \quad 0.01 \times \dfrac{320}{300} A = 5.5 \times 10^{-3} \times \dfrac{h}{120} \times A$

$\Rightarrow \quad h = 232.73 \simeq 233$ mm

19. (b)

Given:

$e_0 = 0.92,$ $\quad H = 5$ m

$\bar{\sigma}_c = 135 \text{ kN/m}^2,$ $\quad C_c = 0.27$

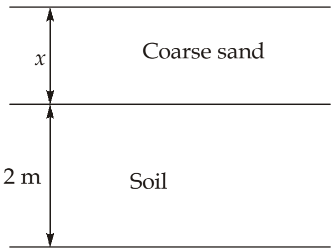
$C_R = 0.03,$ $\quad \bar{\sigma}_0 = 85 \text{ kN/m}^2$

$\Delta\bar{\sigma}_0 = 92 \text{ kN/m}^2$

Now,
$$\Delta H = \frac{C_R H_0}{1+e_0}\log\left(\frac{\bar{\sigma}_c}{\bar{\sigma}_0}\right) + \frac{C_c H_0}{1+e_0}\log\left(\frac{\bar{\sigma}_0 + \Delta\bar{\sigma}_0}{\bar{\sigma}_c}\right)$$
$$= \frac{0.03 \times 5}{1+0.92}\log\left(\frac{135}{85}\right) + \frac{0.27 \times 5}{1+0.92}\log\left(\frac{85+92}{135}\right)$$
$$= 0.0157 + 0.0827$$
$$= 0.0984 \text{ m} \simeq 98.4 \text{ mm}$$

20. (b)

$$i_{cr} = \left(\frac{G-1}{1+e}\right) = (G-1)(1-n)$$
$\Rightarrow$ $$i_{cr} = (2.7 - 1)(1 - 0.3)$$
$\Rightarrow$ $$i_{cr} = 1.19$$
$$i_{\text{allowable}} = \frac{i_{cr}}{FOS}$$
$\Rightarrow$ $$i_{\text{allowable}} = \frac{1.19}{1.5} = 0.7933$$
Now, $$(2 + x) \times 0.793 = 1.9$$
$\Rightarrow$ $$(2 + x) = 2.396$$
$\Rightarrow$ $$x = 0.396 \text{ m} \simeq 0.4 \text{ m}$$



21. (c)

Given:
$$C_c = 1.2$$
$$D_{10} = 0.6 \text{ mm}$$
$$D_{30} = 3.2 \text{ mm}$$
Now, $$C_c = \frac{D_{30}^2}{D_{60} \times D_{10}}$$
$\Rightarrow$ $$1.2 = \frac{(3.2)^2}{D_{60} \times 0.6}$$
$\Rightarrow$ $$D_{60} = 14.22 \text{ mm}$$
Also, $$C_u = \frac{D_{60}}{D_{10}}$$
$\Rightarrow$ $$C_u = \frac{14.22}{0.6}$$
$\Rightarrow$ $$C_u = 23.7 > 6$$
Also, C_c is in between 1 and 3.
∴ Soil is well graded sand.

22. (c)

Given, $\gamma_b = 19$ kN/m^3, $w = 17\%$

So, dry density, $$\gamma_d = \frac{\gamma_b}{1+w} = \frac{19}{1+0.17} = 16.24 \text{ kN/m}^3$$
Also, $$\gamma_d = \frac{G\gamma_w}{1+e} = \frac{2.7 \times 9.81}{1+e} = 16.24$$

$$\Rightarrow \quad e = \frac{2.7 \times 9.81}{16.24} - 1 = 0.631$$

When the soil is fully saturated, $S = 1$,

$$\therefore \quad S \cdot e = w \cdot G$$

So, new moisture content,

$$w = \frac{S \cdot e}{G} = \frac{1 \times 0.631}{2.7} = 0.2337 \text{ or } 23.37\%$$

$\therefore$ Additional moisture content required

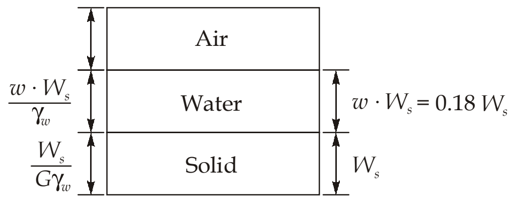
$$= 23.37 - 17 = 6.37\%$$

23. (a)

For the given condition,

$$\text{Final total volume} = \frac{\pi}{4} \times (0.045)^2 \times 0.1$$

$$\Rightarrow \quad V_T = 1.59 \times 10^{-4} \text{ m}^3$$



We know,

$$\text{Water content,} \quad w = \frac{W_w}{W_s}$$

$$\Rightarrow \quad 0.18 = \frac{W_w}{W_s}$$

$$\text{and \% volume of air voids} = \frac{V_a}{V_T} = 0.18$$

So, volume of air, $V_a = 0.18 \times 1.59 \times 10^{-4} \text{ m}^3$

$$= 2.862 \times 10^{-5} \text{ m}^3$$

Now, volume of solids + Volume of water + Volume of air = Total volume

$$\Rightarrow \frac{W_s}{2.7 \times 9.81} + \frac{0.18 \times W_s}{9.81} + 2.862 \times 10^{-5} = 1.59 \times 10^{-4}$$

$$\Rightarrow \quad W_s = 2.324 \times 10^{-3} \text{ kN} = 2.324 \text{ N}$$

$$\Rightarrow \quad W_s = 0.2369 \text{ kg} = 236.9 \text{ gm}$$

$$\therefore \quad \text{Weight of water} = wW_s = 0.18 \times 236.9$$

$$\Rightarrow \quad W_w = 42.64 \text{ gm}$$

Alternatively:

$$\gamma_d = \frac{(1 - \eta_a) G\gamma_w}{1 + wG} = \frac{W_s}{V_T}$$

$$\gamma_d = \frac{(1 - 0.18) 2.7 \times 9.81}{1 + 0.18 \times 2.7} = \frac{W_S}{1.59 \times 10^{-4}}$$

$$W_s = 0.002324 \text{ kN} = 2.324 \times 10^{-3} \text{ kN}$$

$$W_s = 236.9 \text{ gm}$$

Mass of water $wW_s = 0.18 \times 236.9 = 42.68$

24. (d)

For constant head permeability test,

$$k = \frac{Q}{Ai} = \frac{626 \times 18}{\frac{\pi}{4} \times 7.5^2 \times 60 \times 24.7} = 1.72 \times 10^{-1} \text{ cm/s}$$

Discharge velocity, $V = ki$

$$= 1.72 \times 10^{-1} \times \frac{24.7}{18} = 0.236 \text{ cm/s}$$

Seepage velocity, $\frac{V}{n} = \frac{0.236}{0.44}$

$$V_s = 0.536 \text{ cm/s}$$

25. (c)

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

$$T_v = \frac{k}{m_v \gamma_w} \times \frac{t}{d^2}$$

$\because$ Percentage consolidation required is same in both the cases.

$\therefore$ $T_v = T_v'$

$$\frac{k}{m_v \gamma_w} \times \frac{t}{d^2} = \frac{k'}{m_v' \gamma_w} \times \frac{t}{d^2}$$

$$\frac{k}{m_v} \times \frac{15}{d^2} = \frac{3k}{4m_v} \times \frac{t}{(d/2)^2} \qquad [\because k' = 3k \ \& \ m_v' = 4\text{m}]$$

$$15 = 3t$$

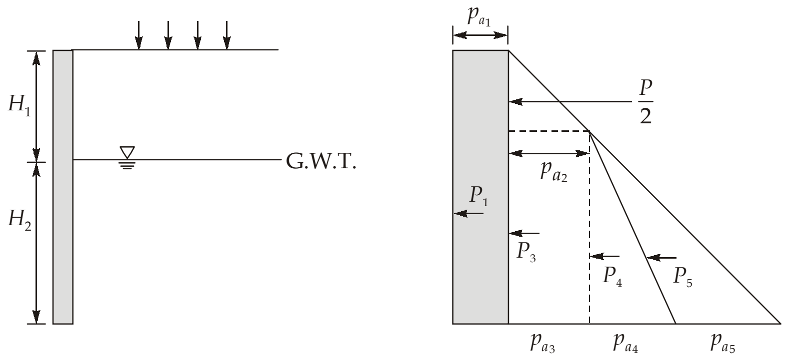
$$t = 5 \text{ years}$$

26. (a)

$$K_a = \tan^2\left(45 - \frac{\phi}{2}\right) = \frac{1 - \sin\phi}{1 + \sin\phi} = \frac{1}{3}$$

$$\gamma_{sat} = \frac{G + e}{1 + e} \cdot \gamma_w = \frac{2.65 + 0.65}{1 + 0.65} \times 9.81 = 19.62 \text{ kN/m}^3$$

$\therefore$ $\gamma' = \gamma_{sat} - \gamma_w = 19.62 - 9.81 = 9.81 \text{ kN/m}^3$



$$p_{a_1} = K_a \times q = \frac{1}{3}\times 14 = 4.67 \text{ kN/m}^2$$

$$p_{a_2} = K_a \cdot \gamma_d \times H_1 = \frac{1}{3}\times 15.755\times 3 = 15.755 \text{ kN/m}^2$$

$$p_{a_3} = p_{a_2} = 15.755 \text{ kN/m}^2$$

$$p_{a_4} = K_a \gamma' H_2 = \frac{1}{3}\times 9.81\times 7 = 22.89 \text{ kN/m}^2$$

$$p_{a_5} = \gamma_w \cdot H_2 = 9.81 \times 7 = 68.67 \text{ kN/m}^2$$

$$P_1 = p_{a_1} \times \text{H} = 4.67 \times 10 = 46.7 \text{ kN/m}$$

$$P_2 = \frac{1}{2}\cdot p_{a_2}\times H_1 = \frac{1}{2}\times 15.755\times 3 = 23.633 \text{ kN/m}$$

$$P_3 = p_{a_3} H_2 = 15.755 \times 7 = 110.285 \text{ kN/m}$$

$$P_4 = \frac{1}{2}\times p_{a_4}\cdot H_2 = \frac{1}{2}\times 22.89\times 7 = 80.115 \text{ kN/m}$$

$$P_5 = \frac{1}{2}\times p_{a_5} H_2 = \frac{1}{2}\times 68.67\times 7 = 240.345 \text{ kN/m}$$

$\therefore$ Total $P_a = 46.7 + 23.633 + 110.285 + 80.115 + 240.345 = 501.08$ kN/m

27. (c)

Samples obtained from auger are disturbed samples

Degree of expansiveness	DFS percent
Low	< 20
Moderate	20 to 35
High	35 to 50
Very High	> 50

28. (b)

Given:

Weight of pile, P_s = 22 kN

Shaft diameter, D_0 = 340 mm

Under-ream dia, D_u = 700 mm

Undrained shear strength, C = 60 kPa

α = 0.3, $N_C = 9$

Ultimate tensile capacity will be due to

1. Friction along the length of pile (P_1)
2. Bearing action caused by under-reamed portion (P_2)
3. Self weight of pile (P_3)

Tensile capacity due to friction

$$P_1 = f_s \times A_s$$

$$= \alpha \,.\, C\,(\pi D_0)\,(L - \text{Depth of under-ream})$$

$$= 0.3 \times 60 \times \pi \times 0.34 \times (10 - 0.42) = 184.19 \text{ kN}$$

Tensile capacity due to bearing action

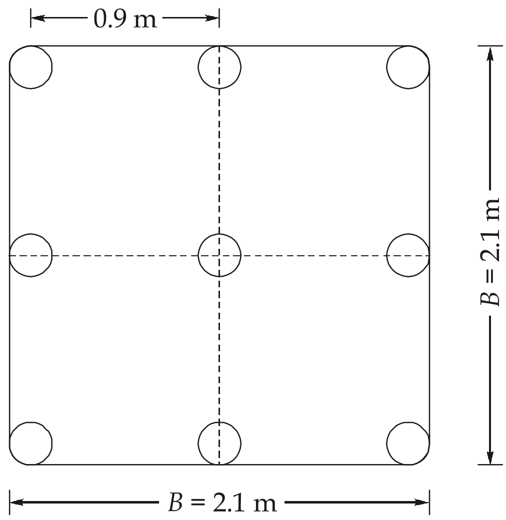
$$P_2 = C N_C \cdot A$$

$$= \frac{60 \times 9\pi(D_u^2 - D_o^2)}{4}$$

$$= \frac{60 \times 9 \times \pi(0.7^2 - 0.34^2)}{4} = 158.79 \text{ kN}$$

$$\therefore \quad P = P_1 + P_2 + P_3$$
$$= 184.19 + 158.79 + 22$$
$$= 364.98 \simeq 365 \text{ kN}$$

29. (c)



$$C_u = \frac{q_u}{2} = \frac{1.5}{2} = 0.75 \text{ kg/cm}^2 = 7.5 \text{ t/m}^2$$

$$B = 2 \times 0.9 + 0.3 = 2.1 \text{ m}$$

(a) Pile acting individually

$$P_n = n \cdot \alpha \cdot C \cdot A_s$$
$$= 9 \times 0.9 \times 7.5 \times (\pi \times 0.3 \times 10)$$
$$= 572.6 \text{ t}$$

(b) Piles acting in a group

$$P_g = C\,(4\,BL) = 7.5 \times 4 \times 2.1 \times 10 = 630 \text{ t}$$

∴ Efficiency for pile group,

$$\eta = \frac{P_g}{P_n} = \frac{630}{572.6} = 1.1$$

30. (b)

$$q_u = 1.3\,C\,N_C + \gamma D_f N_q + 0.4\,\gamma B N_\gamma \cdot R_\gamma$$

$\because$ $C = 0$

$$\therefore \quad q_u = \gamma D_f N_q + 0.4\,\gamma B N_\gamma \cdot R_\gamma$$

$$R_\gamma = 0.5\left(1+\frac{D}{B}\right) = 0.5\left(1+\frac{2.5}{3}\right) = 0.917$$

$$\therefore \quad q_u = 18 \times 1 \times 21 + 0.4 \times 20 \times 3 \times 17 \times 0.917$$
$$= 752.136 \text{ kN/m}^2$$

$$\therefore \quad q_{nu} = q_u - \gamma D_f = 752.136 - 18 \times 1$$
$$= 734.136 \text{ kN/m}^2$$

$$\therefore \quad q_{ns} = \frac{q_{nu}}{\text{FOS}} = \frac{734.136}{2.5} = 293.65 \text{ kN/m}^2$$

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