CLASS TEST

Sl. : 01IGCE_GHIJ_06092024

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IRRIGATION ENGINEERING

CIVIL ENGINEERING

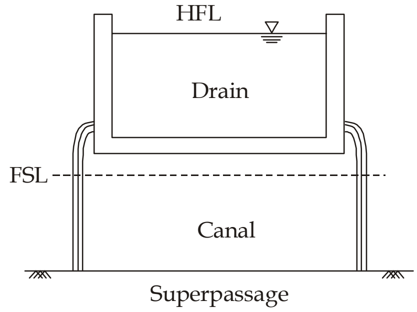
Date of Test : 06/09/2024

ANSWER KEY

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

DETAILED EXPLANATIONS

1. (c)



2. (b)

$$\text{SAR} = \frac{Na^+}{\sqrt{\dfrac{Ca^{+2} + Mg^{+2}}{2}}}$$

$$\text{SAR} = \frac{24}{\sqrt{\dfrac{6 + 3.68}{2}}} = \frac{24}{2.2} = 10.9$$

If SAR is between 10 to 18 then it is classified as medium sodium water and is represented by S2.

3. (c)

The duty at the head of water-course i.e. at the outlet.

7. (a)

The downstream profile has following general equation

$$x^n = kH^{n-1} \times y$$

Slope of upstream face of spillway is vertical then

$$k = 2 \text{ and } n = 1.85$$

$$x^{1.85} = 2H^{1.85-1} \times y$$

$$x^{1.85} = 2H^{1.85}\, y$$

9. (c)

The annual intensity of irrigation is the sum total of intensities of irrigation of all the seasons of the year.

Intensity of irrigation for Kharif = 100 – 76 = 24%

Intensity of irrigation of rabi season = 54%

∴ Annual intensity of irrigation = 24 + 54 = 78%

10. (c)

11. (b)

For the case of horizontal impervious floor with cut-off at the downstream end, the exit gradient is given by,

$$G_E = \frac{H}{d}\frac{1}{\pi\sqrt{\lambda}}$$

$$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2} \qquad \left(\alpha = \frac{b}{d}\right)$$

$$\alpha = \frac{b}{d}$$

Given data: $b = 16 + 4 + 25 = 45$ m, $d = 10$ m, $H = 120 - 102 = 18$ m

$$\alpha = \frac{45}{10} = 4.5 \text{ m}$$

$$\lambda = \frac{1+\sqrt{1+4.5^2}}{2} = 2.805$$

$$G_E = \frac{H}{d}\frac{1}{\pi\sqrt{\lambda}}$$

$$= \frac{120-102}{10} \times \frac{1}{\pi\sqrt{2.805}}$$

$$= 0.342$$

13. (a)

Area of agricultural land, $A = 500$ ha

Base period of crop, $B = 100$ days

Total depth of water required by crop = 130 cm

Depth of rainfall, $P = 10$ cm

Net depth of water required, $\Delta = 130 - 10 = 120$ cm

$\because$ $$\Delta = 8.64 \times \frac{B}{D}$$

$\Rightarrow$ $$D = 8.64 \times \frac{B}{\Delta}$$

$\Rightarrow$ $$D = 8.64 \times \frac{100}{1.2} = 720 \text{ ha/cumec}$$

$\therefore$ Discharge, $$Q = \frac{A}{D} = \frac{500}{720} = 0.6944 \text{ m}^3/\text{s} \simeq 0.694 \text{ m}^3/\text{s}$$

14. (b)

$$\text{SAR} = \frac{[\text{Na}^+]}{\sqrt{\dfrac{[\text{Ca}^{2+}]+[\text{Mg}^{2+}]}{2}}}$$

[ ] in terms of milliequivalents

$$[\text{Na}^+] = \frac{\text{Weight}}{\text{Equivalent weight}} = \frac{250}{\frac{23}{1}} = 10.869 \text{ meq.}$$

$$[\text{Ca}^{+2}] = \frac{100}{\frac{40}{2}} = 5 \text{ meq.}$$

$$[Mg^{2+}] = \frac{35}{\frac{24}{2}} = 2.917 \text{ meq.}$$

$$\text{SAR} = \frac{10.869}{\sqrt{\frac{5+2.917}{2}}} = 5.463 \simeq 5.46$$

15. (b)

Normal scour depth $R = 1.35\left(\frac{q^2}{f}\right)^{1/3} = 1.35\times\left(\frac{9^2}{1}\right)^{1/3} = 1.35\left(3^{4/3}\right) = 5.84 \text{ m}$

16. (c)

For elementary profile, $B = \frac{H}{\sqrt{S_c - C}}$

When uplift is ignored $C = 0$

$\therefore$ $B = \frac{H}{\sqrt{S_c}}$

$\Rightarrow$ $H = 36\sqrt{2.56} = 57.6 \text{ m}$

$\therefore$ Maximum allowable height = 57.6 m.

So, only (c) is correct.

17. (c)

$$\text{NIR} = C_u - P_{eff}$$

$$C_u = 0.5(FC - PWP)\frac{\gamma_d d}{\gamma_w} = 0.5(0.25-0.15)\times\frac{16}{10}\times 1000 = 80 \text{ mm}$$

Effective rainfall = 40 mm

$\therefore$ NIR = 80 – 40 = 40 mm

18. (c)

The limiting height of a low concrete gravity dam considering uplift force is given by

$$H = \frac{f}{\gamma(s-c+1)}$$

$f = 4.5$ MPa

$\gamma = 9.81 \text{ kN/m}^3$

$S = 2.5$

$C = 0.6$

$$H = \frac{4.5}{9.81(2.5-0.6+1)}$$

$$H = \frac{2.8\times10^3}{9.81\times2.9} = 98.42 \text{ m}$$

19. (c)

$$\text{Outlet index for orifice type outlet} = \frac{1}{2}$$

$$\text{Channel index} = \frac{5}{3}$$

$$\text{Setting} = \frac{\text{Outlet index}}{\text{Channel index}} = \frac{1/2}{5/3} = 0.3$$

20. (b)

21. (b)

For no tension $b = \frac{H}{\sqrt{S - C}}$

Since $C = 0$ (No uplift force)

$$b = \frac{H}{\sqrt{S}}$$

$$25 = \frac{H}{\sqrt{2.56}}$$

$$H = 25 \times 1.6 = 40 \text{ m}$$

22. (d)

Net irrigation requirement = Consumptive use – Effective rainfall

$$\text{Consumptive use} = 0.5 \times (0.2 - 0.1) \times \frac{15}{10} \times 1000 = 75 \text{ mm}$$

Effective rainfall = 50 mm

∴ N/R = 75 – 50 = 25 mm

23. (b)

Field capacity is given by,

$$FC = \frac{\text{Weight of water contained in certain volume of soil}}{\text{Weight of the same volume of dry soil}}$$

$$\Rightarrow \quad FC = \frac{\gamma_w}{\gamma_d} \times n$$

$$\Rightarrow \quad \frac{\gamma_d}{\gamma_w} = \frac{n}{FC} = \frac{0.36}{0.35} = 1.03$$

Maximum quantity of water stored between field capacity (FC) and permanent wilting point,

$$d = \frac{\gamma_d}{\gamma_w} \times d \times (FC - \phi)$$

$$= 1.03 \times 0.56 \times (0.35 - 0.15)$$

$$= 0.1154 \text{ m} = 11.54 \text{ cm} \simeq 11.5 \text{ cm}$$

24. (a)

For a trapezoidal section, we have

$$A = bd + d^2(\theta + \cot\theta)$$

$$P = b + 2d(\theta + \cot\theta)$$

$$\text{Side slope} = 1.5\text{ H} : 1\text{ V}$$

$$\cot\theta = \frac{1.5}{1}$$

$$\therefore \quad \theta = 0.59\text{ rad} = 33.69°$$

$$\therefore \quad R = \frac{A}{P} = \frac{bd + d^2(\theta + \cot\theta)}{b + 2d(\theta + \cot\theta)}$$

$$\Rightarrow \quad R = \frac{(45 \times 2.5) + 2.5^2(0.59 + 1.5)}{45 + 2 \times 2.5(0.59 + 1.5)}$$

$$\Rightarrow \quad R = 2.26\text{ m}$$

25. (b)

Bligh's theory

$$\text{Total creep length} = 2 \times 6 + 25 + 2 \times 8 = 53\text{ m}$$

$$\text{Length of creep upto } B = 2 \times 6 + 12 = 24\text{ m}$$

$$\text{Head loss upto } B = \frac{5}{53} \times 24$$

$$\text{Head available at } B = 5 - \frac{5}{53} \times 24 = 2.736\text{ m}$$

$$\text{Uplift pressure} = \gamma_w h$$

$$= 9.81 \times 2.736$$

$$= 26.84\text{ kN/m}^2 \simeq 26.8\text{ kN/m}^2$$

26. (a)

$$\text{Height of dam} = 90\text{ m}$$

$$S_c = 2.4$$

$$C = 0.72$$

$$\mu = 0.6$$

Case-1: Consider no tension criterion.

Width of dam, $$B_{min} = \frac{H}{\sqrt{S_c - C}} = \frac{90}{\sqrt{2.4 - 0.72}} = 69.437\text{ m}$$

Case-2: Consider no sliding criterion

$$B_{min} = \frac{H}{\mu(S_c - C)} = \frac{90}{0.6(2.4 - 0.72)} = 89.286\text{ m}$$

Feasible or minimum width that shall be provided is max (69.437 m, 89.286 m)

$$\therefore \quad B_{min} = 89.286\text{ m} \simeq 89.3\text{ m}$$

27. (a)

Given: Area of strip, $A = 0.06 \text{ hectare} = 0.06 \times 10^4 \text{ m}^2$

Discharge used for irrigation, $Q = 0.05 \text{ m}^3/\text{sec}$

Infiltration capacity, $f = 3 \text{ cm/hr}$

Average depth of flow, $y = 12 \text{ cm}$

We know that,
$$t = 2.3\frac{y}{f}\log_{10}\left(\frac{Q}{Q - fA}\right)$$

$$\Rightarrow \quad t = 2.3 \times \frac{0.12}{0.03}\log_{10}\left(\frac{0.05}{0.05 - \frac{0.03}{3600} \times 600}\right)$$

$$\Rightarrow \quad t = 0.42 \text{ hr}$$

$$\Rightarrow \quad t = 25.2 \text{ minutes}$$

28. (c)

As the reservoir is empty.

∴ Resultant of force will be near to the heel.

$$\therefore \quad (P)_{\text{heel}} = \frac{\Sigma w}{b}\left(1 + \frac{6e}{b}\right)$$

$$= \frac{420}{3.6}\left(1 + \frac{6 \times 0.6}{3.6}\right)$$

$$= 233.33 \text{ kN/m}^2 \text{ (Compressive)}$$

29. (a)

When the area is such that the seasonal water requirement is low, such as hear the coasts.

30. (a)

$$\text{GCA} = 6000 \text{ hectares}$$

$$\text{CCA} = 6000 \times \frac{80}{100} = 4800 \text{ hectares}$$

Area to be irrigated in Rabi season

$$= \text{CCA} \times \text{Intensity of Irrigation}$$

$$= 4800 \times \frac{50}{100} = 2400 \text{ hectares}$$

Area of irrigated in Kharif season $= 4800 \times \frac{25}{100} = 1200$ hectares

Water required at the head of the distributary to irrigate

$$\text{Rabi area} = \frac{2400}{2000} = 1.2 \text{ m}^3/\text{s}$$

Water required at the head of the distributary to irrigate

$$\text{Kharif area} = \frac{1200}{900} = 1.33 \text{ m}^3/\text{s}$$

Thus, the requirement in Kharif season is 1.33 m^3/s and that in Rabi season is 1.2 m^3/s. The required discharge is maximum of the two i.e. 1.33 m^3/s.

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