CLASS TEST

S.No. : 01 JP_CE_250622

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ENGINEERING MECHANICS

CIVIL ENGINEERING

Date of Test : 25/06/2022

ANSWER KEY

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

1. (b)

Intensity of irrigation for kharif = 100 – 65 = 35%

Intensity of irrigation for rabi = 100 – 50 = 50%

∴ Annual intensity of irrigation = sum of seasonal intensity of irrigation in a year

$$= 35\% + 50\% = 85\%.$$

3. (b)

$$D = \frac{8.64B}{\Delta} = \frac{8.64 \times 25}{0.15} = 1440 \text{ ha/m}^3\text{/sec}$$

$$Q = \frac{A}{D} = \frac{2880}{1440} = 2 \text{ m}^3\text{/sec}$$

4. (c)

$$\text{Sodium adsorption ratio (SAR)} = \frac{[Na^+]}{\sqrt{\frac{[Ca^{2+}]+[Mg^{2+}]}{2}}} = \frac{20}{\sqrt{\frac{10+5}{2}}}$$

$$= 7.30$$

5. (a)

As per Kennedy's

Critical velocity, $V_0 = 0.55\, my^{0.64}$

m = critical velocity ratio = 0.90

y = depth of flow = 1.2 m

∴ $V_0 = 0.55 \times 0.9 \times (1.2)^{0.64} = 0.556$ m/sec

Also, discharge through channel, $Q = 4\text{ m}^3\text{/sec}$

∴ Required cross-section area of channel

$$A = \frac{Q}{V_0} = \frac{4}{0.556} \simeq 7.20 \text{ m}^2$$

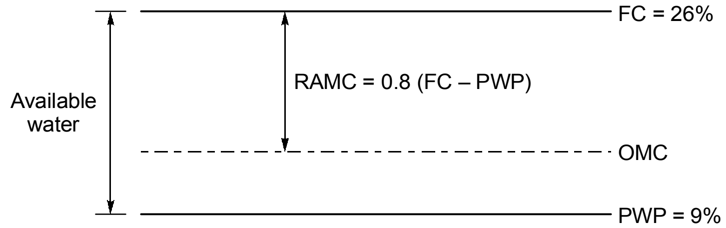
7. (c)

$$\text{Sinuosity of meander} = \frac{\text{Curve length of meander}}{\text{Straight length of meander}}$$

10. (b)

$$\text{Scour depth} = 1.35\left(\frac{q^2}{f}\right)^{1/3} = 1.35\left(\frac{3^2}{1.2}\right)^{1/3} = 2.64 \text{ m}$$

11. (b)



$$d = \text{depth of root zone} = 75 \text{ cm}$$

$$C_u \text{ per day} = 1.58 \text{ cm/day}$$

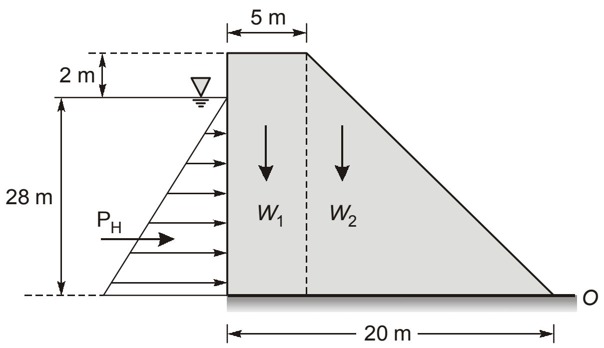
$\therefore$ RAMC = Readily available depth of water

$$= \frac{\gamma_d}{\gamma_w}.d.(FC - OMC) = \frac{1.4}{1} \times 0.75 \times 0.8 \times (0.26 - 0.09)$$

$$= 0.1428 \text{ m}$$

$\therefore$ Frequency of irrigation, $FOI = \frac{RAMC}{C_u} = \frac{(0.1428 \times 100)\text{cm}}{1.58 \text{ cm/day}} = 9.03 \simeq 9 \text{ days}$

14. (b)



$\gamma_c = 24 \text{ kN/m}^3$ (Considering inside length of dam as unity)

Force	Calculation	Magnitude (kN/m)	Lever arm (in m) (about 0)	Moment in (kN-m/m) (about 0)
W_1	24 × 30 × 5	3600	17.5	63000
W_2	1/2 × 24 × 30 × 15	5400	10	54000
P_H	1/2 × 9.8 × $(28)^2$	3845.52	9.33	35878.7

$\therefore$ Resisting moment, $M_R = 63000 + 54000 = 117000$ kN-m/m

Overtuning moment, $M_O = 35878.7$ kN-m/m = 3.26

$\therefore$ FOS against overtuning $= \frac{M_R}{R_O} = \frac{117000}{35878.7} = 3.26$

(FOR) against sliding $= \frac{\mu \Sigma V}{\Sigma H} = \frac{0.5 \times (3600 + 5400)}{3845.52} = 1.17$

15. (c)

Mean depth, $D = \frac{2+1.9+1.8+1.6+1.5}{5} = 1.76$ m

$\therefore$ Value of deviation from mean are (2 – 1.76), (1.9 – 1.76), (1.8 – 1.76), (1.6 – 1.76), (1.5 – 1.76)

$= 0.24, 0.14, 0.04, -0.16, -0.26$

Average of absolute deviations

$$d = \frac{0.24+0.14+0.04+0.16+0.26}{5} = 0.168 \text{ m}$$

Water distribution efficiency, $\eta_d = \left(1-\frac{d}{D}\right)\times 100 = \left(1-\frac{0.168}{1.76}\right)\times 100 = 90.45\%$

16. (b)

As per Lane's, he suggested a weighting factor of 1/3 to horizontal creep and 1 for vertical creep.

$\therefore$ Creep length, $L = 2d_1 + L/3 + 2d_2$

$= 2 \times 8 + 30/3 + 2 \times 10 = 46$ m

$\therefore$ Hydraulic gradient $i = \frac{H}{L} = \frac{6}{46} = 0.13$

17. (d)

Net vertical force, $\Sigma V = W - U = 1036 - 674 = 362$ kN

Net horizontal force, $\Sigma H =$ Water force

$$= \frac{1}{2}\cdot\gamma_w H^2 = \frac{1}{2}\times 9.81\times(10)^2 = 490.5 \text{ kN}$$

$\therefore$ Shear friction factor, $\text{SFF} = \frac{\mu.\Sigma V + B.q}{\Sigma H}$

B = width of the base of foundation = 8.25 m; $\mu = 0.75$; q = shear strength at the joint = 1400 kN/m^2

$$\text{SFF} = \frac{0.75\times 362 + 8.25\times 1400}{490.5} = 24.10$$

18. (d)

Net irrigation water required by wheat crop during base period

= crop requirement of water – rainfall

= 60 – 12 = 48 cm = 0.48 m

Volume of water required, V_1 = area × 0.48 m^3

Volume of water supplied by canal during the base period of 120 days with an irrigation efficiency of 70%

$V_2 = 2.02 \times (120 \times 86400) \times 0.7 = 14660352$ m^3

$V_1 = V_2$

$A \times 0.48 = 14660352$

$A = 30542400$ m^3 = 3054.24 ha

19. (c)

Given, $Q = 50\ m^3/sec$

Silt factor, $f = 1.1$

As per Lacey's

$\therefore$ Velocity, $$V = \left(\frac{Qf^2}{140}\right)^{1/6} = \left(\frac{50 \times (1.1)^2}{140}\right)^{1/6} = 0.869 \text{ m/sec}$$

Bed slope, $$S = \frac{f^{5/3}}{3340\, Q^{1/6}} = \frac{(1.1)^{5/3}}{3340(50)^{1/6}} = 0.0001828$$

$$S = \frac{1}{5469}$$

20. (a)

Leaching requirement, $$LR = \frac{(EC)_i}{(EC)_d}$$

$(EC)_i$ = Electrical conductivity of irrigation water

= 1.2 milli mho/cm

$(EC)_d$ = Electrical conductivity of drained water

= $2 \times (EC)_e$

$(EC)_e$ = Electrical conductivity of saturated soil extract

= 10 milli mho/cm

$\therefore$ $$LR = \frac{(EC)_i}{2.(EC)_e} \times 100 = \frac{1.2}{2 \times 10} \times 100 = 6\%$$

Also, $$LR = \frac{D_d}{D_i}$$

$$D_i = C_u + D_d$$

C_u = consumptive use = 80 mm; D_d = depth of water drained out; D_i = depth of water applied for irrigation

$$LR = \frac{D_i - D_u}{D_i}$$

$$\frac{6}{100} = \frac{D_i - 80}{D_i}$$

$$6\, D_i = 100\, D_i - 80 \times 100$$

$$94\, D_i = 8000$$

$$D_i = 85.1 \text{ mm}$$

21. (c)

Culturable command area = $10^5 \times \frac{75}{100} = 75000$ hectares

for Kharif crop, Area under Kharif crop = $75000 \times \frac{50}{100} = 37500$ hectares

Duty for Kharif crop = 1200 hectares/cumecs

Required discharge for Kharif crop = $\frac{37500}{1200} = 31.25$ cumecs

for Rabi crop, Area under Rabi crop = $75000 \times \frac{55}{100} = 41250$ hectares

$$\text{Duty for Rabi crop} = 1400 \text{ hectares/cumecs}$$

$$\text{Required discharge for Rabi crop} = \frac{41250}{1400} = 29.46 \text{ cumecs}$$

Discharge of the canal at the head of the field should be 31.25 cumecs (as it is maximum).

Now, considering 20% provision for losses,

Required discharge at the head of canal = 31.25 /0.8 = 39.06 cumecs

22. (b)

Given:

$$H = 100 \text{ m}$$
$$S_c = 2.3$$
$$C = 0.75$$

Case (i): No Tension

$$B_{min} = \frac{H}{\sqrt{S_c - C}}$$

Case (ii): No sliding

$$B_{min} = \frac{H}{\mu(S_c - C)}$$

Note: μ is not given so solve by case (i),

$$\therefore \quad B_{min} = \frac{100}{\sqrt{2.3 - 0.75}} = 80.32\text{m}$$

23. (a)

$$\tau_0 = \gamma_w RS = 1000 \times 2.5 \times \frac{1}{10000} = 0.25 \text{ kg/m}^2$$

$$\text{Now, on side slopes, shear stress} = 0.75\, \gamma_w RS = 0.75 \times 0.25$$
$$= 0.1875 \text{ kg/m}^2 \simeq 0.19 \text{ kg/m}^2$$

24. (d)

As per Blaney-Criddle formula

$$C_u \text{ or PET} = \Sigma \frac{kp}{40}[1.8t + 32]$$
$$= \frac{0.65 \times 9.3}{40}[1.8 \times 28 + 32] + \frac{0.72 \times 10.6}{40}[1.8 \times 25 + 32]$$
$$= 27.14 \text{ cm}$$

In above equation, k = consumptive use coefficient/crop factor; p = monthly %age of annual day light hours; t = temperature (°C).

25. (d)

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

where,

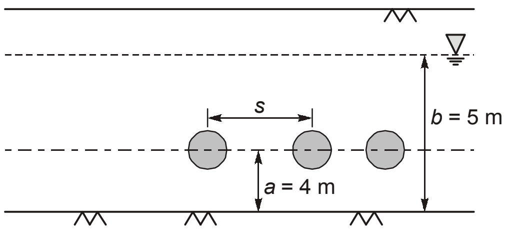
$$H = \text{Total head} = 1.5 \text{ m}$$
$$\lambda = \frac{1 + \sqrt{1 + \alpha^2}}{2}$$
$$d = \text{Depth of d/s cutoff} = 2 \text{ m}$$
$$\alpha = \frac{b}{d} = \frac{13}{2} = 6.5$$

$$\lambda = \frac{1+\sqrt{1+6.5^2}}{2} = 3.79$$

$\therefore$ $$G_E = \frac{1.5}{2}\cdot\frac{1}{\pi\sqrt{3.79}}$$

$\Rightarrow$ $$G_E = 0.123 \simeq 0.12$$

26. (b)



Spacing of tile drain, $$s = \frac{4k}{q}(b^2 - a^2) = \frac{4\times10^{-6}}{1.8\times10^{-6}}\times(5^2-4^2) = 20\text{ m}$$

27. (c)

The deficiency created due to fall of moisture from 25% to 17% is

$$= \frac{16}{9.81}\times\frac{75}{100}\times(0.25-0.17) = 0.0979\text{ m}$$

So, 0.0979 m is the net irrigation requirement.

$\therefore$ Quantity of water required to be supplied to the field irrigation requirement is

$$\text{FIR} = \frac{NIR}{\eta_a} = \frac{0.0979}{0.75} = 0.1305\text{ m} = 13.05\text{ cm}$$

29. (c)

Water depth required at canal $= \dfrac{\text{water depth requied in the field}}{\eta_a.\eta_c} = \dfrac{8}{0.72\times0.87} = 12.77$ cm

Volume of water required $= 8\times10^4\times12.77\times10^{-2} = 10216$ kl

30. (d)

Depth of water in root zone at field capacity per metre depth of soil,

$$d_{w_1} = 0.5\text{ m}$$

Depth of water in root zone at permanent wilting point per metre depth of soil,

$$d_{w_2} = 0.2\text{ m}$$

Depth of soil, d = 1 m,

$$\gamma_d = 12.5\text{ kN/m}^3$$

$$\gamma_w = 10\text{ kN/m}^3$$

$$\text{Field capacity} = \frac{\gamma_w\cdot d_{w_1}}{\gamma_d\cdot d} = \frac{10\times0.5}{12.5\times1} = 0.40 = 40\%$$

$$\text{Permanent wilting point} = \frac{\text{Field capacity}}{0.5}\times0.2 = 0.16 = 16\%$$

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