CLASS TEST

S.No. : 01 IGCE_D+E_180324

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Railway + Airport

CIVIL ENGINEERING

Date of Test : 18/03/2024

ANSWER KEY

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

DETAILED EXPLANATIONS

1. (c)

Composite Sleeper Index (CSI), measures the mechanical strength of timber, derived from its composite properties of strength and hardness

$$\text{CSI} = \frac{S + 10H}{20}$$

where, S = Strength index at 12% moisture content

H = Hardness index at 12% moisture content.

2. (d)

Length of BG rail = 12.8 m

$$\text{Number of BG rails in 800 m} = \frac{800}{12.8} = 62.5 \simeq 63$$

Sleeper density = 12.8 + 5 = 17.8 $\simeq$ 18 sleepers per rail

$\therefore$ Number of sleepers = 18 × 63 = 1134

3. (a)

Grade provided = Ruling gradient – Grade compensation

= 1 in 250 – 0.04% × 4°

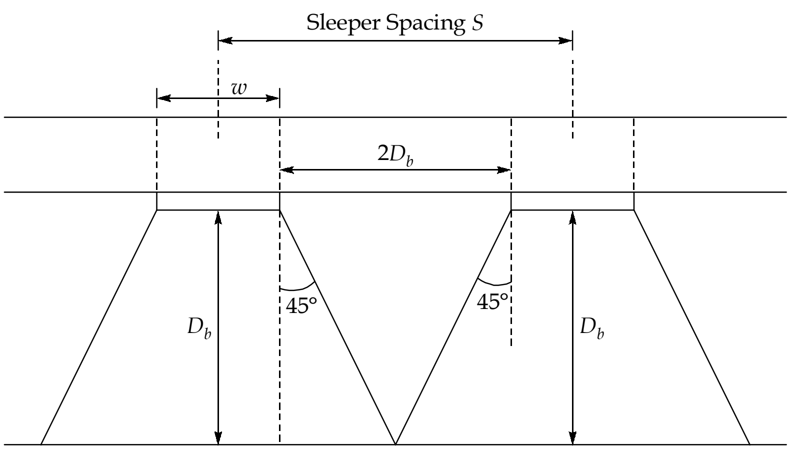
$$= \frac{1}{250} - \frac{0.16}{100}$$

= 0.0024 = 0.24%

4. (d)

$$\text{Radius of exit taxiway,} \quad R = \frac{V^2}{125 f} = \frac{80^2}{125 \times 0.15} = 341.33 \simeq 342 \text{ m}$$

5. (d)



From figure,

$$S = 2\,D_b + w$$

$$D_b = \frac{S-w}{2} = \frac{65-25}{2} = 20 \text{ cm}$$

6. (b)

$$\text{CL} = 2\text{ GN}$$
$$= 2 \times 1.676 \times 16$$
$$= 53.63 \text{ m}$$

7. (b)

8. (b)

9. (b)

Standard atmospheric temperature

$$= 15° - (0.0065 \times \text{Change in elevation above MSL})$$
$$= 15°\text{C} - (0.0065 \times 700)$$
$$= 15 - 4.55$$
$$= 10.45°\text{C}$$

10. (d)

Population, agriculture and industrial development factors are utilized in deciding the best alignment.

11. (b)

Grade resistance + Curve resistance = Gradient resistance

$$\Rightarrow \quad W \tan\theta + 0.04\% \times 4 \times W = \frac{W}{200}$$

$$\Rightarrow \quad W \tan\theta + 0.0004 \times 4° \times W = \frac{W}{200}$$

$$\Rightarrow \quad \tan\theta = \frac{1}{200} - 0.0004 \times 4$$

$$= 3.4 \times 10^{-3} = \frac{1}{294}$$

12. (b)

$$R = 250 \text{ m}$$
$$e = 20 \text{ cm}$$
$$V_{max} = 58.84 \text{ kmph}$$

$$\therefore \quad \text{Length of transition curve} = \max \begin{cases} 7.2e = 7.2 \times 20 = 144 \text{ m} \\ 0.073(e)V_{\max} = 0.073 \times 20 \times 58.84 = 85.91 \text{ m} \end{cases}$$

$$= 144 \text{ m}$$

13. (a)

Length of track, $l = (D-G)N + G\left(4N - \sqrt{1+N^2}\right)$

Given, $N = 15$, $D = 7.5\text{m}$, $G = 1.676$ m

$$l = (7.5-1.676)\times 15 + 1.676\left(4\times 15 - \sqrt{1+15^2}\right)$$
$$= 87.36 + 75.36$$
$$= 162.73 \text{ m}$$

The length of straight distance

$$= l - 4\,GN$$
$$= 162.73 - 4 \times 1.676 \times 15$$
$$= 62.17 \text{ m}$$

14. (c)

$$w = \frac{13(B+L)^2}{R} = \frac{13(6+0.05)^2}{250}$$
$$= 1.903 \text{ m}$$

15. (c)

Hauling capacity $= \mu n w_d$

$= 0.2 \times 3 \times 20 = 12$ tonnes

For train moving on straight and level track,

Hauling capacity = Total train resistance

Total train resistance $= R_{T1} + R_{T2} + R_{T3} + R_g$ $\quad (\because R_g = W + \tan\theta = 0)$

R_{T1} = resistance independent of speed = $0.0016w$

R_{T2} = resistance dependent of speed = $0.00008wv = (0.00008 \times 100)w = 0.008w$

R_{T3} = atmospheric resistance = $0.0000006wv^2 = (0.0000006 \times 100^2)w = 0.006w$

$\therefore \quad 12 = 0.0016w + 0.008w + 0.006w$

$\Rightarrow \quad 12 = 0.0156w$

$\Rightarrow \quad w = 769.23 \text{ tonnes} \simeq 769 \text{ tonnes}$

16. (a)

Gate capacity for single gate,

$$G_C = \frac{1}{\text{Weighted service time}}$$
$$= \frac{1}{(0.2\times 30)+(0.2\times 40)+(0.6\times 60)}$$
$$= 0.02 \text{ aircraft/min/gates}$$

Capacity of all gates C, $= G_C \times$ Number of gate

$= 0.02 \times 20$

$= 0.4$ aircraft/min

$= 24$ aircraft/hour

17. (a)

Type of airport	Maximum rate of change of longitudinal gradient
A and B	0.1% per 30 m length
C type	0.2% per 30 m length
D and E type	0.4% per 30 m length

18. (a)

$$\text{Hauling capacity} = \mu WN$$

$$W = \text{Load on each driving axle}$$

$$\Rightarrow \quad W = 10 \times 2 = 20 \text{ tonnes}$$

$$N = \text{Number of axles}$$

$$\Rightarrow \quad N = 3$$

$$\therefore \quad \text{Hauling capacity} = 0.3 \times 20 \times 3 = 18 \text{ tonnes}$$

19. (a)

Radius of broad gauge curve,

$$R = \frac{1146}{3} = 382 \text{ m}$$

$$e_{eq} = \frac{GV^2}{127R} = \frac{1.676 \times 70^2}{127 \times 382} = 0.169 \text{ m} > 0.165 \text{ m}$$

Adopt $e_{eq} = 0.165$ m

$$e_{th} = e_{eq} + \text{CD}$$

$$= 16.5 + 7.6 = 24.1 \text{ cm}$$

$$\therefore \quad 24.1 = \frac{1.676 \times V_{max}^2}{127 \times 382} \times 100$$

$$\Rightarrow \quad V_{max} = 83.52 \text{ kmph}$$

20. (b)

$$R = \frac{0.388w^2}{\frac{T}{2} - S}$$

$$R = \frac{0.388w^2}{\frac{T}{2} - \left[6 + \frac{\text{Trade of main landing gear}}{2}\right]}$$

$$300 = \frac{0.388 \times 35^2}{\frac{22.5}{2} - \left[6 + \frac{\text{Trade of main landing gear}}{2}\right]}$$

Trade of main landing gear = 7.332 m ≈ 7.33 m

21. (d)

Crosswind is considered to select the correct orientation of runway using wind-rose diagram.

22. (b)

$$\text{Internal force developed} = (E \times T)A$$

$$F = 25 \times 10^5 \times 2 \times 10^5 \times 40 \times 50 = 100000 \text{ kg}$$

$$\text{Resistance of track} = 1000 \text{ kg/km}$$

$$\text{Length to resist at one end} = \frac{100000}{1000} = 100 \text{ km}$$

$$\text{Total breathing length required} = 200 \text{ km}$$

23. (c)

$$\text{A.R.T.} = T_a + \frac{1}{3}(T_m - T_a)$$

$$= 25 + \frac{1}{3}(35 - 25) = 28.33°\text{C}$$

24. (d)

(i) Turning radius, $R = \dfrac{V^2}{125 \times f} = \dfrac{50^2}{125 \times 0.15} = 133.33$ m

(ii) From Horonjeff's equation,

$$R = \frac{0.388W^2}{\left[\frac{T}{2} - S\right]} = \frac{0.388 \times 18^2}{\frac{22.5}{2} - \left(6 + \frac{6.5}{2}\right)} = 62.86 \text{ m}$$

(iii) For super-sonic jet,

$$R = 180 \text{ m}$$

$$\therefore \quad R_{min} = [\text{Maximum of (i), (ii) and (iii)}] = 180 \text{ m}$$

25. (c)

- Zero fuel weight is the sum of empty operating weight and maximum payload.
- Maximum landing weight is less than maximum takeoff weight because fuel is burned during flight.
- Maximum ramp weight is greater than maximum takeoff weight because extra fuel is also required for taxing.

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