CLASS TEST

S.No.:01IGCE_ABC_01092024

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HIGHWAY

CIVIL ENGINEERING

Date of Test :01/09/2024

ANSWER KEY

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

DETAILED EXPLANATIONS

1. (c)

In case of flexible pavement the no. of repetition to failure decrease with increase of stiffness.

2. (c)

The deformation at the failure point expressed in units of 0.25 mm is called the Marshall flow value of the specimen.

3. (c)

$$\text{Curve resistance} = T(1-\cos\alpha) = 60\,(1-\cos 60°) = 30 \text{ kN}$$

4. (c)

$$\frac{\Delta_{flexible}}{\Delta_{rigid}} = \frac{1.5}{1.18} = 1.27$$

5. (a)

When the gradients are not equal, the lowest point lies on the side of flatter grade, and this point is at a distance $x = L\sqrt{\frac{n_1}{2N}}$ from the tangent point of the first grade n_1.

$$N = n_1 + n_2 = \left|\frac{-2}{100} - \frac{1}{100}\right| = 0.03$$

$$\therefore \quad x = 100\sqrt{\frac{0.02}{2\times 0.03}} = \frac{100}{\sqrt{3}} = 57.7 \text{ m}$$

6. (a)

7. (d)

8. (b)

CBR method, Group index method, McLeod and Burmister method are some of the methods which are used in the design of flexible pavements.

9. (a)

Given: $n_a = 21,\ n_w = 350,\ V = 70$ kmph

$$T_w = T_a = \frac{8}{70} \text{ hr}$$

$$q = \frac{n_a + n_w}{T_a + T_w} = \frac{350+21}{\left(\frac{8}{70}+\frac{8}{70}\right)} \simeq 1624 \text{ vehicles/hr}$$

10. (c)

$$\text{Capacity} = \text{Velocity} \times \text{Density}$$
$$C = u \times k = 65\,k - 0.65\,k^2$$

Now,
$$\frac{dC}{dk} = 65 - 1.3\,k = 0$$
$$k = \frac{65}{1.3} = 50$$

∴
$$\text{Capacity, } C = 65 \times 50 - 0.65 \times 50^2 = 1625 \text{ veh/hr}$$

11. (a)

$$y_a = \frac{q_a}{S_a} = \frac{400}{1250} = 0.32$$
$$y_b = \frac{q_b}{S_b} = \frac{250}{1000} = 0.25$$
$$Y = y_a + y_b = 0.32 + 0.25 = 0.57$$
$$L = 2n + R = 2 \times 2 + 12 = 16 \text{ sec}$$
$$C_0 = \frac{1.5L + 5}{1 - Y} = \frac{1.5 \times 16 + 5}{1 - 0.57}$$
$$= \frac{29}{0.43} = 67.44 \text{ sec}$$
$$G_a = \frac{y_a}{Y}(C_0 - L) = \frac{0.32}{0.57}(67.44 - 16) = 28.88 \text{ sec}$$
$$G_b = \frac{y_b}{Y}(C_0 - L) = \frac{0.25}{0.57}(67.44 - 16) = 22.56 \text{ sec}$$

All red time for pedestrian crossing = 12 sec

Providing Amber times of 2.0 sec each for clearance, total cycle time

$$= 28.88 + 22.56 + 12 + 4 = 67.44 \approx 67.4 \text{ sec}$$

12. (b)

Length of transition curve based on rate of change of superelevation is given by,

$$L_S = \frac{v^3}{CR}$$
$$C = \frac{80}{75 + V} = \frac{80}{75 + 80} = 0.5161 \text{ m/s}^3$$

As the value of C is $0.5 < C < 0.8$, we can apply the formula.

$$L_S = \frac{(0.278 \times 80)^3}{0.5161 \times 150} = 142.095 \text{ m}$$

According to IRC formula,

$$L_S = \frac{2.7V^2}{R} = \frac{2.7 \times 80^2}{150} = 115.2 \text{ m}$$

Maximum of the above two values is taken as length of transition curve,

i.e. $L_S = 142$ m

13. (c)

Expansion joint spacing = L_s

$$= \frac{\delta'}{100C(T_2 - T_1)}$$

$$\delta' = \frac{1}{2} \times (\text{expansion joint gap}) = 1.25 \text{ cm}$$

$$\therefore \quad L_s = \frac{1.25}{100 \times 10^{-5} \times 30} = 41.7 \text{ m}$$

Contraction joint spacing

$$L_c = \frac{2S_c \times 10^4}{W.f} = \frac{2 \times 0.8 \times 10^4}{2400 \times 1.5} = 4.4 \text{ m}$$

14. (b)

Overtaking sight distance for one way traffic = $d_1 + d_2$

$$d_1 = 0.278\, V_b \times t_R = 0.278 \times 50 \times 2 = 27.8 \text{ m}$$

$$d_2 = 0.278\, V_b T + 2S$$

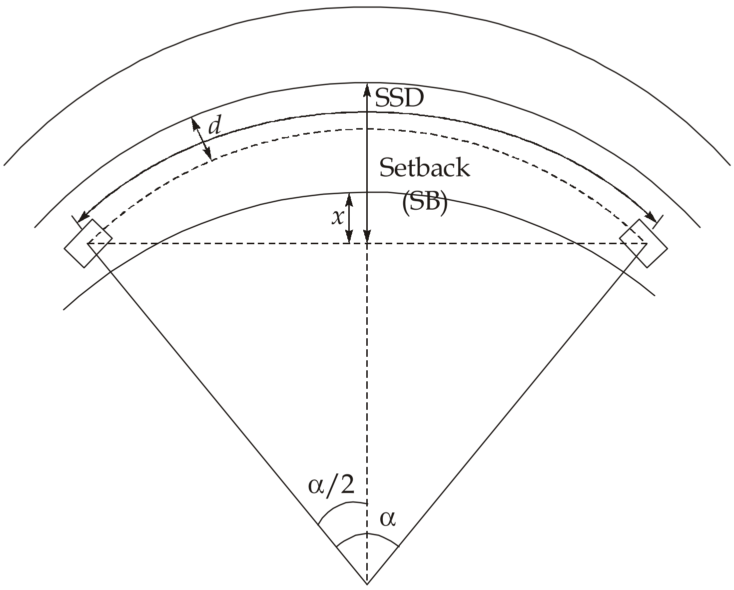
$$S = 0.7\, V_b + 6 = 0.2\left(\frac{50 \times 1000}{3600}\right) + 6 = 16 \text{ m}$$

$$T = \sqrt{\frac{4s}{a}} = \sqrt{\frac{4 \times 16}{1}} = 8 \text{ sec}$$

$$d_2 = 0.278 \times 50 \times 8 + 2 \times 16 = 143.2 \text{ m}$$

$$\therefore \quad OSD = d_1 + d_2 = 27.8 + 143.2 = 171 \text{ m}$$

15. (d)



$R = 400$ m
$l = 225$ m
$S = 90$ m
$l > S$
$d = \frac{3.8}{2} = 1.9$ m

$$\therefore \quad L_c \text{ (225 m)} > \text{SSD (90 m)}$$

∴ Setback distance,

$$SB = R - (R - d)\cos\frac{\alpha}{2}$$

$$\frac{\alpha}{2} = \frac{SSD}{(R-d)} \times \frac{180}{2\pi} = \frac{90}{(400 - 1.9)} \times \frac{180}{2\pi} = 6.48°$$

$$SB = 400 - (400 - 1.9) \times \cos 6.48°$$

$$= 4.443 \text{ m}$$

Setback distance from mid of the inner lane (x)

$$= 4.443 - 1.9 = 2.543 \text{ m}$$

16. (a)

Given: $A = 5500$ vehicles, $r = 6.5\%$ per annum, construction period = 3 years

Traffic flow after 3 year,

$$= 5500\times\left(1+\frac{6.5}{100}\right)^3 = 6643.72 \text{ cvpd}$$

$$\simeq 6644 \text{ cvpd}$$

$$\text{VDF} = \left(\frac{L}{L_s}\right)^4 = \left[\frac{3000}{8160}\right]^4 = 0.018, \text{ where } L = \frac{2500+3500}{2} = 3000 \text{ kg}$$

$$\text{Equivalent axle load} = 365\times 6643.72\times\frac{\left[(1+0.065)^{15}-1\right]}{\left(\frac{6.5}{100}\right)}\times 0.018\times 1 = 1.05 \text{ msa}$$

17. (b)

Maximum expansion allowed,

$$\delta = \frac{3}{2} = 1.5 \text{ cm} = 1.5\times 10^{-2} \text{ m}$$

$$\Delta T = T_2 - T_1 = 30°\text{C}$$

Coefficient of thermal expansion,

$$\alpha = 10\times 10^{-6}/°\text{C}$$

∴ Spacing of expansion joint, L

$$= \frac{\delta}{\alpha(T_2-T_1)} = \frac{1.5\times 10^{-2}}{10\times 10^{-6}\times 30} = 50 \text{ m}$$

18. (c)

Braking distance for travelling upgrade,

$$S_1 = \frac{V^2}{254(f+0.01n)}$$

Braking distance for travelling downgrade

$$S_2 = \frac{V^2}{254(f-0.01n)}$$

Give, $S_2 = 2S_1$

$$\Rightarrow \frac{1}{(f-0.01n)} = \frac{2}{f+0.01n}$$

$$\Rightarrow 2f - 0.02\,n = f + 0.01\,n$$

$$\Rightarrow n = \frac{f}{0.03} = \frac{0.3}{0.03} = 10\%$$

19. (d)

$$\text{Grade compensation} = \frac{30+R}{R} \le \frac{75}{R}$$

$$= \frac{30+100}{100} \le \frac{75}{100} = 1.3 \ge 0.75$$

As $1.3 > 0.75$

∴ Grade compensation = 0.75

Note : Here grade compensation is asked, not the compensated gradient, so no need to subtract it from the given grade.

20. (d)

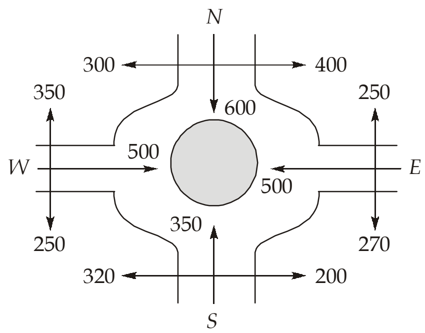
$$\text{Optimum signal cycle, } C_0 = \frac{1.5L+5}{1-(y_A+y_B)} = \frac{1.5\times 10+5}{1-(0.15+0.45)} = 50 \text{ seconds}$$

$$\text{Flow on road } A = \text{Green time of road } A$$

$$\Rightarrow \quad G_A = \frac{y_A}{y}(C_0-L) = \frac{0.15}{0.6}(50-10) = 10 \text{ seconds}$$

$$\text{Percent time flow on road } A = \frac{G_A}{C_0}\times 100 = \frac{10}{50}\times 100 = 20\%$$

21. (c)



$$p = \text{Weaving ratio} = \frac{b+c}{a+b+c+d}$$

where b and c are weaving traffic and a and d are non weaving traffic.

For North-East:

$$a = 400; \quad b = (600 + 300) = 900;$$

$$c = 500 + 200 = 700; \quad d = 250$$

$$\therefore \quad p = \frac{900+700}{400+900+700+250} = 0.71$$

22. (d)

$$\text{Theoretical specific gravity, } G_t = \frac{w_1+w_2+w_3+w_4}{\frac{w_1}{G_1}+\frac{w_2}{G_2}+\frac{w_3}{G_3}+\frac{w_4}{G_b}}$$

$$= \frac{45+40.8+4.2+10}{\frac{45}{2.65}+\frac{40.8}{2.72}+\frac{4.2}{2.60}+\frac{10}{1.10}} = 2.34$$

Effective specific gravity of aggregates (coarse + fine) is given by

$$G' = \frac{(45\times 2.65)+(40.8\times 2.72)}{45+40.8} = 2.68$$

23. (c)

24. (c)

Equilibrium superlevation:

$$f = 0$$

The superelevation required to balance the vehicle over a curve only with superelevation without considering friction.

$$e + f = \frac{v^2}{gR}$$

$$e_{eq} = \frac{v^2}{gR}$$

25. (d)

In intersection design: Relative speed is dependent on the absolute speeds of the intersecting vehicles and the angles between them when the angle of merging is small, the relative speed will also be low. As relative speed increases, the judgement of drivers regarding time and distance is likely to be more inaccurate, thus increasing the possibility and severity of accidents.

26. (b)

Marshall test is used for design of bituminous concrete mix i.e., option (b) is correct.

27. (d)

28. (d)

$$\frac{t_1}{t_2} = \left(\frac{C_2}{C_1}\right)^{1/5}$$

$$\therefore \quad C_2 = \left(\frac{10}{7.5}\right)^5 \times 60 = (1.33)^5 \times 60 \simeq 250$$

29. (c)

The spacing of expansion joint is given by

$$L_e = \frac{\delta}{2\alpha\Delta T}$$

$$= \frac{2\times10}{2\times10\times10^{-6}\times(50-20)} = 33333.33 \text{ mm} = 33.33 \text{ m}$$

30. (b)

Camber is provided to drain rain water from the surface of pavement. Therefore higher the absorbing capacity of surface, lower will be the camber required to drain water quickly. So correct sequence in order of steepness of camber is

Cement Concrete roads < Bituminous high speed roads < WBM roads < Gravel roads.

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