CLASS TEST

S.No. : 03_SK_CE_S+G_240622

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HIGHWAY ENGINEERING

CIVIL ENGINEERING

Date of Test : 24/06/2022

ANSWER KEY

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

DETAILED EXPLANATIONS

1. (c)

Given: $V = 120$ kmph, $e = 0.07$ and $f = 0.15$

We know that, $$e + f = \frac{V^2}{127R}$$

$$\Rightarrow \quad 0.07 + 0.15 = \frac{120^2}{127R_{min}}$$

$$R_{min} = 515.40 \text{ m} \simeq 516 \text{ m}$$

2. (a)

We know, $$\frac{\Delta}{2} = L\alpha\Delta T$$

$$\Rightarrow \quad \frac{2.5}{100 \times 2} = L \times 10 \times 10^{-6} \times 30$$

$$L = 41.67 \text{ m}$$

3. (c)

$$\text{Hourly expansion factor} = \frac{25000}{5000} = 5$$

4. (b)

$$\text{Rulling gradient} = 5\%$$

$$\text{Grade compensation} = \frac{30+R}{R} = \frac{30+50}{50} = 1.6\%$$

$$\text{Maximum limit of grade compensation} = \frac{75}{R} = \frac{75}{50} = 1.5\%$$

$$\text{Compensated gradient} = 5 - 1.5 = 3.5\%$$

but it should not be less than 4%

$$\text{So, provided gradient} = 4\%$$

5. (c)

Psychological widening is given by

$$= \frac{V}{9.5\sqrt{R}} = \frac{80}{9.5\sqrt{250}} = 0.532 \text{ m}$$

7. (a)

Crossing conflicts are only 16 out of 24 conflict points.

8. (a)

$$q_{max} = \frac{k_j V_f}{4}$$

$\therefore \quad q_{max}$ will be at $\dfrac{k_j}{2}$ and $\dfrac{V_f}{2}$

11. (a)

With increase in bitumen content void content decreases.

12. (a)

$$V = 60 \text{ kmph} = 16.66 \text{ m/s}$$

We know that, SSD = 260 m

$$\therefore \quad SSD = Vt + \frac{V^2}{2g(\eta_b \times f - n\%)}$$

$$\Rightarrow \quad 260 = 16.66 \times 2.5 + \frac{16.66^2}{2 \times 9.81 \times (\eta_b \times 0.4 - n)}$$

$$\Rightarrow \quad 218.35 = \frac{16.66^2}{2 \times 9.81 \times (0.8 \times 0.4 - n)}$$

$$\Rightarrow \quad 0.32 - n = 0.064$$

$$\Rightarrow \quad n = 0.256$$

$$\therefore \quad n\,\% = 25.6\%$$

13. (b)

V_1 = 90 kmph = 25 m/s $\quad V_2$ = 60 kmph = 16.66 m/s

f = 0.40, $\quad t$ = 2.5 sec, $\quad \eta_b$ = 50%

$$SSD = vt + \frac{V^2}{2gf \cdot \eta_b}$$

$$SSD_1 = 25 \times 2.5 + \frac{25^2}{2 \times 9.81 \times 0.4 \times 0.5} = 221.77 \text{ m}$$

$$SSD_2 = 16.66 \times 2.5 + \frac{(16.66)^2}{2 \times 9.81 \times 0.4 \times 0.5} = 112.38 \text{ m}$$

Total distance required = 221.77 + 112.38 = 334.15 m

14. (d)

Normal flow on road A, q_a = 500 PCU/hr

Normal flow on road B, q_b = 300 PCU/hr

Saturation flow on road A, S_a = 1500 PCU/hr

Saturation flow on road B, S_b = 1000 PCU/hr

All red time, R = 16 sec

Number of phases, n = 2

$$y_a = \frac{q_a}{S_a} = \frac{500}{1500} = 0.33$$

$$y_b = \frac{q_b}{S_b} = \frac{300}{1000} = 0.3$$

$$Y = y_a + y_b = 0.33 + 0.3 = 0.63$$

Total lost time, $L = 2n + R = 2 \times 2 + 16 = 20$ sec.

$$\text{Optimum cycle time, } C_o = \frac{1.5L + 5}{1 - Y} = \frac{1.5 \times 20 + 5}{1 - 0.63} = 94.59 \simeq 95 \text{ sec.}$$

15. (a)

Given: $V = 100$ kmph,

$R = 400$ m,

$N = 150$

Required superelevation,

$$\Rightarrow \quad e = \frac{V^2}{225R} = \frac{100^2}{225 \times 400} = 0.11$$

$e \leq 0.07$ for plain and rolling

Hence provide, $e = 0.07$

Since $R > 300$ m, extra widening is not required

$$\text{Length of transition curve } (L_t) = \left(\frac{(w + w_e)eN}{2}\right) \qquad w_e = 0 \quad \text{as R > 300 m}$$

$$= \frac{(7 \times 0.07 \times 150)}{2} = 36.75 \text{ m}$$

16. (a)

$$\text{The capacity of rotary, } Q_P = \frac{280w\left(1 + \frac{e}{w}\right)\left(1 - \frac{p}{3}\right)}{\left(1 + \frac{w}{L}\right)}$$

$w = 15$ m, $p = 0.6$, $L = 75$ m, $e = 5$ m

$$\Rightarrow \quad Q_p = \frac{280 \times 15 \times \left(1 + \frac{5}{15}\right)\left(1 - \frac{0.60}{3}\right)}{\left(1 + \frac{15}{75}\right)} = 3733.33 \simeq 3733 \text{ PCU/hr}$$

17. (c)

Design traffic is given by,

$$N = \frac{365 \times A\left[(1 + r)^n - 1\right]}{r} \times \text{LDF} \times \text{VDF}$$

where, A = traffic in year of completion of construction in terms of CVD

r = annual growth rate

n = design life in years

LDF = lane distribution factor

VDF = vehicle damage factor

$$\therefore \quad N = \frac{365 \times 2100 \times \left[(1 + 0.08)^{16} - 1\right]}{0.08} \times 3 \times 0.75$$

$N = 522.98 \times 10^5$ standard axles

18. (c)

Mean rate of arrival per unit time,

$$\lambda = \frac{100}{3600} = \frac{1}{36} \text{veh/second}$$

$$\text{Mean rate of service, } \mu = \frac{150}{3600} = \frac{1}{24} \text{veh/hour}$$

$$\text{Traffic intensity, } \rho = \frac{\lambda}{\mu} = \frac{\left(\frac{1}{36}\right)}{\left(\frac{1}{24}\right)} = \frac{24}{36} = \frac{2}{3}$$

Average time spent by the vehicle in the system,

$$\bar{d} = \frac{1}{\mu(1-\rho)} = \frac{1}{\frac{1}{24} \times \left(1 - \frac{2}{3}\right)} = 72 \text{ seconds}$$

Average time spent by the vehicle in the queue,

$$\bar{w} = \frac{\rho}{\mu(1-\rho)} = \frac{\left(\frac{2}{3}\right)}{\frac{1}{24}\left(1 - \frac{2}{3}\right)} = \frac{2}{3} \times 72 = 48 \text{ seconds}$$

Total time spent in the system and in queue = 72 + 48 = 120 seconds.

19. (c)

$$s = 0.2\,V_b + 6 = 0.2 \times 60 + 6 = 18$$

Given: $t_R = 2$ sec; $a = 3$ kmph/sec $= 3 \times \frac{5}{18} = 0.833 \text{ m/s}^2$

$$d_1 = 0.278\,V_b \times t_R = 0.278 \times 60 \times 2 = 33.36 \text{ m} \quad \text{...(i)}$$

$$T = \sqrt{\frac{4s}{a}} = \sqrt{\frac{4 \times 18}{0.833}} = 9.297 \text{ seconds}$$

$$d_2 = 0.278\,V_b \times T + \frac{1}{2}aT^2$$

$$= 0.278 \times 60 \times 9.297 + \frac{1}{2} \times 0.833 \times 9.297^2 = 191.073 \text{ m} \quad \text{...(ii)}$$

$$d_3 = 0.278\,V_c \times T$$

$$= 0.278 \times 80 \times 9.297 = 206.76 \text{ m} \quad \text{...(iii)}$$

Therefore, OSD on two–way traffic road is summation of (i), (ii) and (iii)

$$= d_1 + d_2 + d_3 = 33.36 + 191.073 + 206.76 \approx 431.20 \text{ m}$$

21. (a)

Theoretical specific gravity of mix,

$$G_t = \frac{100}{\frac{55}{2.62} + \frac{35.2}{2.72} + \frac{4.8}{2.70} + \frac{5}{1.02}} = 2.46$$

22. (c)

$$s = 0.278\ Vt + L = 0.278 \times 40 \times 0.8 + 6$$
$$= 14.90 \text{ m}$$

$$\text{Theoretical capacity, } C = \frac{1000\ V}{s} = \frac{1000 \times 40}{14.90}$$
$$= 2684 \text{ vehicles/hour/lane}$$

23. (c)

$$p = \frac{1400}{\pi \times \frac{35^2}{4}} = 1.455 \text{ kg/cm}^2$$

$$k_{35} \text{ for 35 cm diameter plate } = \frac{p}{\Delta}$$

$$k_{35} = \frac{1.455}{0.125} = 11.64 \text{ kg/cm}^3$$

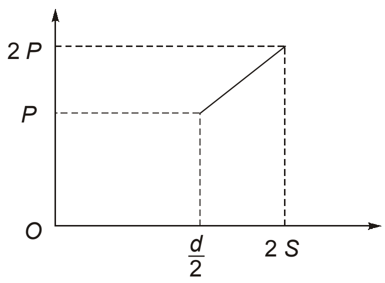
k_{75} for standard plate of diameter 75 cm

$$k_{75} = k_{35} \times \frac{35}{75} = 5.43 \text{ kg/cm}^3$$

24. (b)

The points joining the line are

$$\left(\log P, \log \frac{d}{2}\right) \text{ and } (\log 2P, \log 2S)$$



Given, $P = 2044$ kg, $d = 11$ cm, $S = 27$ cm

The equation of line is

$$\log(\text{ESWL}) = m \log t + C$$

$$m = \frac{\log 2P - \log P}{\log 2S - \log\left(\frac{d}{2}\right)} = 0.303$$

From point [log P, log(d/2)],

$$\log(2044) = 0.303 \log\left(\frac{11}{2}\right) + C$$

$$\Rightarrow \quad C = 3.086$$

$$\log(\text{ESWL}) = 0.303 \log t + 3.086$$

For $t = 15$ cm,

$$\log(\text{ESWL}) = 0.303 \log 15 + 3.086$$
$$\text{ESWL} = 2770 \text{ kg}$$

For $t = 20$ cm,

$$\log(\text{ESWL}) = 0.303 \log 20 + 3.086$$
$$\text{ESWL} = 3020 \text{ kg}$$

25. (d)

If superelevation is not available than take camber as superelevation.

$$\therefore \qquad e = 4.0\% = 0.04$$

$$R_{min} = \frac{V^2}{127e} = \frac{(75)^2}{127 \times 0.04} = 625 \text{ m}$$

30. (a)

$$\text{Capacity} = \frac{1000V}{S}$$

$$S = 0.2V + L = 0.2 \times 60 + 6 = 18 \text{ m}$$

$$\text{Capacity} = \frac{1000 \times 60}{18} \times 2 = 6666.7 \simeq 6700$$

The closest answer is 6800.

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