CLASS TEST

S.No.:02SK_CE_ABCD_03072025

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HIGHWAY

CIVIL ENGINEERING

Date of Test : 03/07/2025

ANSWER KEY

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

DETAILED EXPLANATIONS

1. (a)

$$\text{ISD - SSD} = 93.2 \text{ m}$$

But $\text{ISD} = 2\,\text{SSD}$

So, $\text{SSD} = 93.2$ m (Headlight sight distance = Stopping sight distance)

$$\therefore \quad \text{SSD} = 0.278V \times t + \frac{(0.278 \times V)^2}{2gf}$$

$$\Rightarrow \quad 93.2 = 0.278 \times 65 \times 2.5 + \frac{(0.278 \times 65)^2}{2 \times 9.81 \times f}$$

$$\Rightarrow \quad f = 0.3465 \simeq 0.35$$

2. (c)

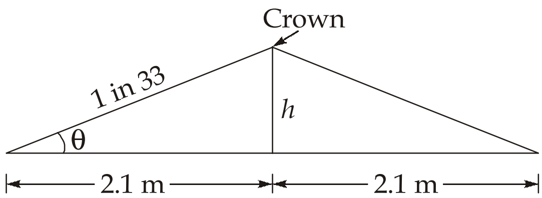
Deviation angle, $N = n_1 - n_2$

$= (-4.2 - 3.3) = -7.5\%$ (valley)

Location of deepest point,

$$x = \left(\frac{n_1}{2N}\right)^{1/2} L_V = \left(\frac{4.2}{2 \times 7.5}\right)^{1/2} \times 280 = 148.16 \text{ m}$$

3. (d)



$$\tan\theta = \frac{1}{33} = \frac{h}{\left(\frac{4.2}{2}\right)}$$

$$\Rightarrow \quad h = 0.06364 \text{ m}$$

$$= 63.64 \text{ mm}$$

4. (c)

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

5. (c)

$$\text{Daily expansion factor, DEF} = \frac{\text{Average traffic volume per week}}{\text{Average traffic volume per day}}$$

$$= \frac{250500}{32000} = 7.828$$

6. (b)

$$\text{Space mean speed} = \frac{nL}{\Sigma\,\text{time}} = \frac{4 \times 400 \times 10^{-3}}{\left(\frac{400}{25} + \frac{400}{35} + \frac{400}{42} + \frac{400}{48}\right)10^{-3}} = 35.33 \text{ km/hr}$$

7. (b)

$$\text{Jam density} = K_j = \frac{1000}{7} \text{ veh/km}$$

$$\text{Maximum flow} = \left(\frac{V_{S_f} \times K_j}{4}\right) = \frac{84 \times \frac{1000}{7}}{4} = 3000 \text{ veh/hr}$$

8. (c)

$\because$ Single lane road is there.

$\therefore$ Psychological widening, $W_p = 0$

Now, extrawidening required will be equal to mechanical widening only.

$$W_e = W_m$$

$$\Rightarrow \quad W_e = \frac{nl^2}{2R}$$

$$\Rightarrow \quad W_e = \frac{1 \times 7^2}{2 \times 225} = 0.1089 \text{ m} = 10.89 \text{ cm}$$

$\therefore$ Option (c) is correct.

9. (c)

$\because$ Radius > 300 m

$\therefore$ As per IRC, extra widening is not required.

$$W_e = 0$$

10. (a)

Absolute minimum radius,

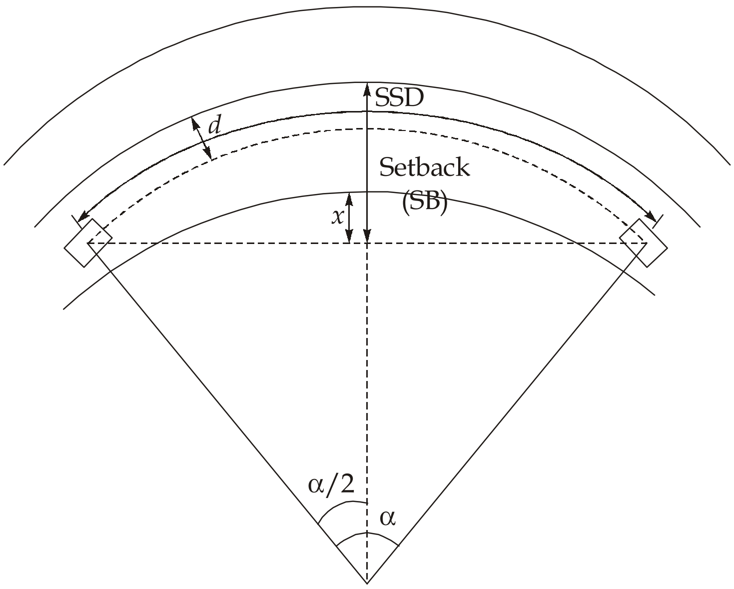
$$R_{\min} = \frac{V^2}{127(e+f)}$$

where, $V = 80$ km/hr (For NH in plain terrain)

$e = 0.07$, $f = 0.15$ (As per IRC)

$$\therefore \quad R_{\min} = \frac{(80)^2}{127(0.07 + 0.15)} = 229.06 \text{ m}$$

11. (d)



$R = 400$ m

$l = 225$ m

$S = 90$ m

$l > S$

$d = \frac{3.8}{2} = 1.9$ m

$\therefore$ L_c (225 m) > SSD (90 m)

$\therefore$ 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) × cos 6.48°

= 4.443 m

Setback distance from mid of the inner lane (x)

= 4.443 – 1.9 = 2.543 m

12. (c)

Assume $L > SSD$

$$L = \frac{NS^1}{\left(\sqrt{2h_1}+\sqrt{2h_2}\right)^2} = \frac{NS^2}{2\left(\sqrt{h_1}+\sqrt{h_2}\right)^2}$$

$N = n_1 - n_2$

$$= \frac{1}{55}-\left(-\frac{1}{50}\right) = 0.0382$$

S = 190 m

h_1 = height of driver's eye

h_2 = height of object

$$\therefore \quad L = \frac{0.0382\times190^2}{2\left(\sqrt{1.15}+\sqrt{0.21}\right)^2}$$

$\Rightarrow$ L = 294.304 m > 190 m (Safe)

13. (d)

$$SSD = 0.278Vt+\frac{V^2}{254(f\pm n)}$$

For a vehicle on ascending gradient

$$SSD_1 = 278Vt+\frac{V^2}{254(f+n)}$$

$$= 0.278\times85\times2.5+\frac{85^2}{254(0.36+0.025)}$$

$\Rightarrow$ = 132.95 m

For a vehicle coming from opposite direction i.e., descending gradient

$$SSD_2 = 278Vt+\frac{V^2}{254(f-n)}$$

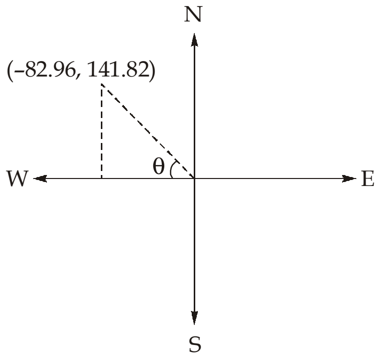
$$= 0.278\times85\times2.5+\frac{85^2}{254(0.36-0.025)}$$

$\Rightarrow$ $= 143.98$ m

For a one lane, two way road

$$SSD = SSD_1 + SSD_2$$
$$= 132.95 + 143.98$$
$$= 276.93$$

14. (a)



$$\tan\theta = \frac{141.82}{82.96} = 1.7095°$$

$\therefore$
$$\theta = \tan^{-1}(1.7095) = 59.674°$$
$$WCB = 270 + \theta = 270 + 59.674 = 329.674°$$
$$= 329.674 \times \pi \text{ rad} = 5.75 \text{ rad}$$

15. (b)

Deviation angle,
$$N = \left|-\frac{1}{80} - \frac{1}{50}\right|$$

$\Rightarrow$
$$N = \frac{1}{30.77}$$

Assume,
$$L_v > SSD$$

$\therefore$
$$L_v = \frac{NS^2}{2h + 2S\tan\alpha}$$
$$= \frac{\frac{1}{30.77} \times 250^2}{2 \times 0.85 + 2 \times 250 \times \tan 1.5°}$$
$$= 137.31 \text{ m} < SSD\ (= 250 \text{ m})$$

Hence, assumption was wrong

$\therefore$
$$L_v < SSD$$

$\therefore$
$$L_v = 2S - \frac{2h + 2S\tan\alpha}{N}$$

$\Rightarrow$
$$L_v = 2 \times 250 - \frac{2 \times 0.85 + 2 \times 250 \times \tan 1.5°}{\frac{1}{30.77}}$$

$\Rightarrow$
$$L_v = 500 - 455.179$$

$\Rightarrow$
$$L_v = 44.82 \text{ m} < SSD\ (= 250 \text{ m}) \quad \text{(OK)}$$

16. (a)

Radius of relative stiffness, $$l = \left[\frac{Eh^3}{12K(1-\mu^2)}\right]^{1/4}$$

$$\Rightarrow \quad l = \left[\frac{2.8\times10^5\times30^3}{12\times8\times(1-0.15^2)}\right]^{1/4}$$

($\therefore K = 8 \times 10^6$ kg/m^3 = 8 kg/cm^3)

$$\Rightarrow \quad l = 94.74 \text{ cm}$$

Warping stress at corner is given by

$$S_{tc} = \frac{E\alpha T}{3(1-\mu)}\sqrt{\frac{a}{l}}$$

$$P = \pi a^2 p$$

$$\Rightarrow \quad 4000 = \pi a^2 \times 5$$

$$\Rightarrow \quad a = 15.96 \text{ cm}$$

$$S_{tc} = \frac{2.8\times10^5\times10\times10^{-6}\times12}{3(1-0.15)}\sqrt{\frac{15.96}{94.74}}$$

$$= 5.41 \text{ kg/cm}^2$$

17. (c)

$$\frac{\log(ESWL)-\log(P)}{\log(2P)-\log(ESWL)} = \frac{\log Z - \log\frac{d}{2}}{\log 2S - \log Z} \quad \ldots\text{(i)}$$

Here,
ESWL = 62 kN
P = 35 kN
Z = 30 cm
S = 20 cm
d = ?

Substitute all the values in eq. (i)

$$\frac{\log 62 - \log 35}{\log 70 - \log 62} = \frac{\log 30 - \log\frac{d}{2}}{\log 40 - \log 30}$$

$$\Rightarrow \quad d = 15.47 \text{ cm}$$

18. (c)

Theoretical specific gravity, $$G_t = \frac{825+1200+325+150+100}{\frac{825}{2.63}+\frac{1200}{2.51}+\frac{325}{2.46}+\frac{150}{2.43}+\frac{100}{1.05}}$$

$$G_t = 2.4055 \text{ g/cc}$$

Bulk specific gravity, $$G_m = \frac{M}{V}$$ ($\because \rho_w$ = 1 g/cc)

$$\Rightarrow \quad G_m = \frac{1100}{475} = 2.316 \text{ g/cc}$$

Percentage of air voids, $V_v = \frac{G_t - G_m}{G_t} \times 100$

$= \frac{2.4055 - 2.316}{2.4055} \times 100$

$= 3.72\%$

Total weight of all constituents = 825 + 1200 + 325 + 150 + 100 = 2600 g

Percentage of volume of bitumen, $V_b = G_m \times \frac{W_b\%}{G_b}$

$= 2.316 \times \frac{\frac{100}{2600} \times 100}{1.05}$

$= 8.48\%$

∴ VMA $= V_v + V_b$

$= 3.72 + 8.48$

$= 12.2\%$

Voids filled with bitumen, VFB $= \frac{V_b\%}{VMA\%} \times 100$

$= \frac{8.48}{12.2} \times 100$

$= 69.51\% \simeq 0.695$

19. (b)

$$y_N = \frac{q_N}{S_n} = \frac{900}{2500} = 0.36$$

$$y_S = \frac{q_S}{S_S} = \frac{500}{2000} = 0.25$$

∴ Maximum value of $\frac{q}{S}$ in N-S direction = 0.36

$$y_E = \frac{q_E}{S_E} = \frac{800}{3200} = 0.25$$

$$y_W = \frac{q_W}{S_W} = \frac{1000}{3000} = 0.33$$

∴ Max value of $\frac{q}{S}$ in E-V direction = 0.33.

Total lost time = 4 × 2 = 8 sec

$$C_0 = \frac{1.5L + 5}{1 - Y} = \frac{1.5 \times 8 + 5}{1 - (0.36 + 0.33)} = 54.84 \text{ sec}$$

20. (b)

Speed of overtaking vehicle, V = 80 kmph = 22.22 m/sec

Speed of overtaken vehicle,

V_b = 50 kmph = 13.89 m/sec

Average acceleration during overtaking,

$$a = 0.95 \text{ m/sec}^2$$

Overtaking sight distance for two way traffic,

$$\text{OSD} = d_1 + d_2 + d_3$$
$$= (V_b t + V_b T + 2S + VT)$$
$$d_1 = V_b t = 13.89 \times 2.5 = 34.7 \text{ m}$$
$$d_2 = V_b T + 2S$$
$$S = 0.7V_b + 6 = 0.7 \times 13.89 + 6 = 15.723 \text{ m}$$
$$T = \sqrt{\frac{4S}{a}} = \sqrt{\frac{4 \times 15.723}{0.95}} = 8.136 \text{ sec}$$
$$d_2 = 13.89 \times 8.136 + 2 \times 15.723 = 144.5 \text{ m}$$
$$d_3 = VT = 22.22 \times 8.136 = 180.8 \text{ m}$$
$$\text{OSD} = d_1 + d_2 + d_3 = 34.7 + 144.5 + 180.8 = 360 \text{ m}$$

Now, minimum length of overtaking zone = 3 × OSD = 3 × 360 = 1080 m

Also, desirable length of overtaking zone = 5 × OSD = 5 × 360 = 1800 m

21. (a)

Radius of relative stiffness,

$$l = \left[\frac{Eh^3}{12k(1-\mu^2)}\right]^{1/4} = \left[\frac{3 \times 10^5 \times 15^3}{12 \times 3(1-0.15^2)}\right]^{1/4}$$

$$\Rightarrow \quad l = 73.24 \text{ cm}$$

For the equivalent radius of resisting section

$$\because \quad \frac{a}{h} = \frac{15}{15} = 1 < 1.724$$

$$\therefore \quad b = \sqrt{1.6a^2 + h^2} - 0.675h$$
$$= \sqrt{1.6 \times 15^2 + 15^2} - 0.675 \times 15$$
$$= 14.06 \text{ cm}$$

Stress at edge,

$$S_e = \frac{0.572P}{h^2}\left[4\log_{10}\left(\frac{l}{b}\right) + 0.359\right]$$
$$= \frac{0.572 \times 4100}{15^2} \times \left[4\log_{10}\left(\frac{73.24}{14.06}\right) + 0.359\right]$$
$$= 33.63 \text{ kg/cm}^2$$

22. (b)

$$\text{CBR}_{2.5} = \frac{\text{Load sustained by specimen at 2.5 mm penetration}}{\text{Load sustained by standard aggregate at 2.5 mm penetration}} \times 100$$
$$= \frac{55}{1370} \times 100 = 4.01\%$$

$$\text{CBR}_{5.0} = \frac{\text{Load sustained by specimen at 5.0 mm penetration}}{\text{Load sustained by standard aggregate at 5.0 mm penetration}} \times 100$$

$$= \frac{75}{2055} \times 100 = 3.65\%$$

Thus, the higher value of CBR which is obtained at 2.5 mm penetration is adopted i.e. 4.01%

23. (a)

$$\text{Design speed} = 80 \text{ km/hr}$$

$$N = |n_1 - n_2| = \left|\frac{1}{40} - \left(-\frac{1}{20}\right)\right| = 0.075$$

$$\text{Stopping sight distance} = 120 \text{ m}$$

Length of valley curve by sight distance criterion:

Assuming (L > SSD)

$$L_V = \frac{NS^2}{1.5 + 0.035S}$$

$$= \frac{0.075 \times 120^2}{1.5 + 0.035 \times 120} = 189.47 \text{ m} > \text{SSD} \qquad \text{OK}$$

$$\text{From comfort criterion, } L_V = 2\left[\frac{NV^3}{c}\right]^{1/2} = 0.38\left(NV^3\right)^{1/2}$$

$$= 0.38\,[0.075 \times 80^3]^{1/2}$$

$$= 74.46 \text{ m}$$

24. (d)

As, vehicle travelling towards upgrade requires 10 m less than travelling towards downgrade with same grade, so

$$\frac{V^2}{254(f+n)} = \frac{V^2}{254(f-n)} - 10$$

$$\Rightarrow \quad \frac{65^2}{254(0.4+n)} = \frac{65^2}{254(0.4-n)} - 10$$

$$\Rightarrow \quad 16.63\left(\frac{1}{0.4-n} - \frac{1}{0.4+n}\right) = 10$$

$$\Rightarrow \quad 3.33n = 0.4^2 - n^2$$

$$\Rightarrow \quad n^2 + 3.33n - 0.4^2 = 0$$

$$\Rightarrow \quad n = 0.0474$$

So, gradient of pavement is 4.74%.

25. (d)

Transition curve: Introduced between a straight and a circular curve.

Objects of providing transition curve:

(i) To introduce gradually the centrifugal force between the tangent points and beginning of circular curve, avoiding sudden jerk on the vehicle.

(ii) To enable the driver turn the steering gradually for comfort and safety.

(iii) It introduces superelevation and extra widening on curve gradually.

(iv) To improve aesthetic appearance of road.

26. (c)

Road	Length (km)	Total utility served by the road	Utility per unit length	Priority
P	500	$100 \times 1 + 70 \times 2 + 50 \times 4 + 20 \times 8 + 50 \times 2 + 20 \times 10 = 900$	$\frac{900}{500} = 1.8$	II
Q	600	$200 \times 1 + 120 \times 2 + 30 \times 4 + 10 \times 8 + 60 \times 2 + 25 \times 10 = 1010$	$\frac{1010}{600} = 1.683$	IV
R	800	$100 \times 1 + 90 \times 2 + 80 \times 4 + 80 \times 8 + 30 \times 2 + 15 \times 10 = 1450$	$\frac{1450}{800} = 1.625$	I
S	900	$150 \times 1 + 130 \times 2 + 100 \times 4 + 10 \times 8 + 50 \times 2 + 12 \times 10 = 1110$	$\frac{1110}{900} = 1.23$	IV

27. (b)

$$\text{Bulk specific gravity} = \frac{1000}{1010-610} = 2.5$$

$$\text{Water absorption} = \frac{1010-1000}{1000} \times 100 = 1\%$$

28. (c)

$$V_b = 50 \text{ kmph}$$

$$s_1 = 20 \text{ m and } s_2 = 16 \text{ m}; \quad s = s_1 + s_2 = 36 \text{ m}$$

$$a = 0.5 \text{ m/s}^2$$

$$T = \sqrt{\frac{2(s_1+s_2)}{a}} \Rightarrow T = \sqrt{\frac{2(20+16)}{0.5}}$$

$$\Rightarrow \quad T = 12 \text{ sec}$$

Distance travelled by overtaking vehicle is

$$d = 0.278 V_b T + (s_1 + s_2)$$

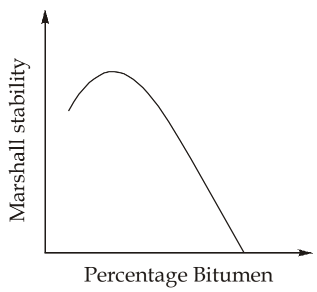
$$\Rightarrow \quad d = 0.278 \times 50 \times 12 + 36$$

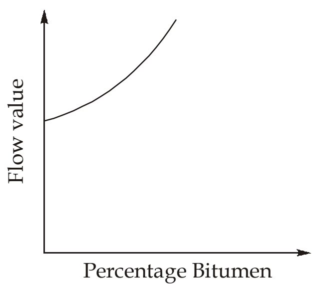
$$\Rightarrow \quad d = 202.8 \text{ m}$$

29. (d)

The vehicle turning on a horizontal curve with no superelevation has to fully depend on coefficient of friction. In such case, vehicle will skid if value of friction coefficient is less than $\frac{b}{2h}$ and would overturn if friction coefficient is more than $\frac{b}{2h}$.

30. (b)





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