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Highway Engineering

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CLASS TEST 2019-2020

CIVIL ENGINEERING

Date of Test : 05/07/2019

ANSWER KEY ➤ Highway Engineering

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

DETAILED EXPLANATIONS

1. (d)
In special cases like villages and mountaineous region, a super elevation of 10° can be provided.

6. (d)
$$K_1 d_1 = K_2 d_2$$
$$\therefore \quad K_2 = \frac{30}{75} \times 200 = 80 \text{ N/cm}^3$$

8. (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,
$$\alpha = 10 \times 10^{-6}/°\text{C}$$
$\therefore$ Spacing of expansion joint, L
$$= \frac{\delta}{\alpha(T_2 - T_1)} = \frac{1.5 \times 10^{-2}}{10 \times 10^{-6} \times 30} = 50 \text{ m}$$

11. (c)
When a vehicle traverses a horizontal curve, the centrifugal force acts horizontally outwards through the centre of gravity of the vehicle. This centrifugal force is counteracted by the transverse frictional resistance developed between the tyres and the pavement which enables the vehicle to change the direction along the curve and to maintain the stability of the vehicle.
Summit curves are designed so as to provide adequate sight distance.

12. (a)
To cater for mixed traffic condition 75% of design velocity will be considered.
$$\therefore \quad \text{Super elevation, } e = \frac{V^2}{225R} = \frac{(100)^2}{225 \times 500} = \frac{4}{45}$$
$$\text{Raising of outer edge} = \frac{4}{45} \times \left(\frac{7.5}{2}\right) = \frac{1}{3} \text{ m}$$

13. (a)
Longitudinal friction coefficient,
$$f = \frac{a}{g}$$
$$\Rightarrow \quad 0.35 = \frac{a}{9.81}$$
$$\Rightarrow \quad a = -3.43 \text{ m/s}$$

14. (b)
$$\text{Ruling gradient} = \frac{1}{25}$$
$$\text{Radius of curve} = 100 \text{ m}$$

$$\text{Grade compensation} = \left(\frac{30+R}{R}\right)\% \not> \left(\frac{75}{100}\right)\%$$

$$= \left(\frac{30+100}{100}\right)\% \not> \left(\frac{75}{100}\right)\% = 1.3\% \not> 0.75\ \%$$

$$\therefore \quad \text{Compensated gradient} = \left(\frac{1}{25} - \frac{0.75}{100}\right) = \frac{13}{400}$$

16. (c)

$$\text{Jam density, } k_j = \frac{1000}{\text{space headway}}$$

$$= \frac{1000}{5} = 200\text{veh./km}$$

$$\text{Maximum flow, } q_{max} = \frac{k_j \times V_{sf}}{4}$$

$$= \frac{200 \times 76}{4} = 3800 \text{ vph}$$

17. (d)

$$\frac{t_1}{t_2} = \left(\frac{c_2}{c_1}\right)^{1/5}$$

$$\therefore \quad c_2 = \left(\frac{10}{7.5}\right)^5 \times 60 = (1.33)^5 \times 60 \simeq 250$$

18. (b)

Worst combination of stresses in summer will be at the bottom of pavement

= load stress + warping stress – frictional stress

= 30 + 8 – 7

= 31 kN/m^2

19. (b)

$$h_0 = 550 \log_{10}\left(\frac{D_c}{D_a}\right) = 550 \log_{10}\left(\frac{1.5}{1}\right)$$

$$= 550 \log_{10}\left(\frac{30}{20}\right) = 550\left[\log_{10} 30 - \log_{10} 20\right] = 96.85 \text{ mm}$$

20. (c)

$$Y_a = \frac{q_a}{s_a} = \frac{400}{1250} = 0.32$$

$$Y_b = \frac{q_b}{s_b} = \frac{250}{1000} = 0.25$$

$$Y = Y_a + Y_b = 0.32 + 0.25 = 0.57$$

$$L = 2n + R = 2 \times 2 + 12 = 16 \text{ sec}$$

$$C_0 = \frac{1.5L+5}{1-Y} = \frac{1.5 \times 16 + 5}{1 - 0.57} = 67.5 \text{ sec}$$

21. (d)

$$S = 0.278\ Vt + L = 0.278 \times 40 \times 1 + 6 = 17.12 \text{ m}$$

Theoretical capacity,

$$C = \frac{1000\ V}{S} = \frac{1000 \times 40}{17.12} = 2336 \text{ vehicles/hour/lane}$$

22. (a)

$$e + f = \frac{V^2}{127R}$$

$$\therefore \quad e = \frac{50^2}{127 \times 100} - 0.15 = 0.04685$$

24. (b)

$$v = \frac{90 \times 5}{18} = 25 \text{ m/s}$$

$$\text{SSD} = 25 \times 2 + \frac{25^2}{2 \times 9.81 \times 0.35} = 141 \text{ m}$$

Since the traffic is two way, SSD = 2 × 141 = 282 m

25. (d)

$\because$ Pavement width is 7 m and thus it is a two lane road i.e. $n = 2$

$$w_m = \frac{nl^2}{2R} = \frac{2 \times 7^2}{2 \times 250} = 0.196$$

27. (c)

$$\frac{a}{h} = \frac{15}{20} = 0.75 < 1.724$$

$$b = \sqrt{1.6a^2 + h^2} - 0.675h = 14.07 \text{ cm}$$

28. (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.

30. (c)

Flow of traffic stream (q) by floating car method is

$$q = \frac{n_a + n_y}{t_a + t_w}$$

$$n_a = 200,\ n_y = 20$$

$$t_a = t_w = \frac{3}{60} = \frac{1}{20} \text{hrs}$$

$$q = \frac{200 + 20}{\frac{1}{20} + \frac{1}{20}} = 2200 \text{ vehicles per hour}$$

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