Transportation Infrastructure Test 1

Number of Questions: 25 **Time: 60 min.**

Directions for questions 1 to 25: Select the correct alternative from the given choices.

1. Indian Road Congress was established in the year ____.
(A) 1932 (B) 1930
(C) 1934 (D) 1936

2. The maximum grade compensation necessary to ease the gradients at horizontal curves is _____.
(A) $\frac{60}{R}$ (B) $\frac{30+R}{R}$
(C) $\frac{75}{R}$ (D) $\frac{40+R}{R}$

3. The length of the summit curve for a stopping sight distance of 100 m with an upward gradient of 1% and downward gradient of 2% is _____.
Take the height of the eye of the driver to be 1.2 m and the height of the object above the roadways to be 0.15 m.
(A) 62 m (B) 65 m
(C) 73 m (D) 69 m

4. The extra widening necessary on a two lane pavement for a curve of radius 80 m and wheel base 6 m with a design speed of 65 kmph is _____.
(A) 1.23 m (B) 1.43 m
(C) 1.17 m (D) 1.13 m

5. Width of roadway of two lane national highway in mountainous and steep terrain is
(A) 6.25 m (B) 8.8 m
(C) 4.75 m (D) 9 m

6. An aggregate is said to be exceptionally strong when the aggregate impact value is
(A) less than 10. (B) 10 to 20.
(C) 20 to 30. (D) above 35.

7. Bitumen of viscosity 80/100 penetration grade is used for
(A) spraying applications
(B) paving applications in cold regions
(C) paving applications in hot regions
(D) high stress areas like toll plaza, terminals etc.

8. Length of the transition curve for comfort condition is _____.
(A) $L_S = \frac{V^3}{CR}$ (B) $L_S = \frac{L}{2}$
(C) $L_S = \sqrt{\frac{NV^3}{C}}$ (D) All of the above

9. The minimum length of overtaking zone should be $(d_1 + d_2 + d_3 = OSD)$
(A) $2(d_1 + d_2 + d_3)$ (B) $5(d_1 + d_2 + d_3)$
(C) $3(d_1 + d_2 + d_3)$ (D) $4(d_1 + d_2 + d_3)$

10. The sight distance available to a driver travelling on the road at any instance depends on the following, factors.
I. height of drivers eyes above the road surface
II. height of object above the road surface
(A) Both I and II are true
(B) I is false and II is true
(C) Both I and II are false
(D) I is true and II is false

11. Which of the following relation is true
(A) Ruling gradient < limiting gradients < exceptional gradient
(B) limiting gradient > ruling gradient > exceptional gradient
(C) Exceptional gradient < limiting gradient < Ruling gradient
(D) Ruling gradient > limiting gradients > exceptional gradient

12. Calculate the safe stopping sight distance on a level road, stretch for design speed of 40 kmph for a two way traffic on a single lane road assuming coefficient of friction as 0.37 and reaction time of driver as 2.5 seconds.
(A) 44.79 m (B) 45.68 m
(C) 89.59 m (D) 88.63 m

Common Data for Questions 13 and 14:
The radius of horizontal circular curve is 400 m. The design speed is 80 kmph and coefficient of lateral friction is 0.1.

13. Calculate the super elevation required (if the lateral friction is assumed to develop).
(A) 0.58 (B) 0.025
(C) 0.007 (D) 0.48

14. Coefficient of friction needed if no super elevation is provided is _____.
(A) 0.15 (B) 0.19
(C) 0.125 (D) 0.087

Common Data for Questions 15 and 16:
A vertical summit curve is to be designed when two grades $+\frac{1}{20}$ and $-\frac{1}{50}$ meet on the highway. The stopping sight distance and over taking sight distance required are 120 m and 600 m respectively. The length of vertical the curve is restricted to a maximum value of 500 m.

15. The length of the summit curve needed to fulfill the requirements of stopping sight distance is _____.
(A) 228 m (B) 229 m
(C) 230 m (D) 222 m

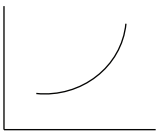
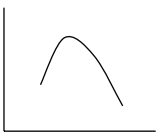
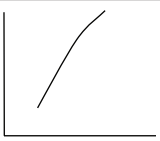
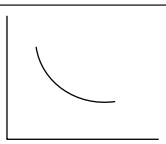
16. The length of summit curve needed to fulfill the requirements of overtaking sight distance is _____.
(A) 1052.7 m (B) 1048.9 m
(C) 1062.8 m (D) 1073.9 m

Common Data for Questions 17 and 18:
The wheel load of 5100 kg is applied on a pavement of thickness 18 cm, modulus of elasticity 3×10^5 kg/cm^2, radius of contact area 15 cm and Poisson's ratio = 0.15. modulus of subgrade reaction = 6kg/cm^3.

17. The stress at the corner of the slab is __.
(A) 24.27 kg/cm^2
(B) 22.56 kg/cm^2
(C) 25.96 kg/cm^2
(D) 26.5 kg/cm^2

18. The location where a crack develops due to corner load is _____.
(A) 85 cm (B) 84.5 cm
(C) 84 cm (D) 84.3 cm

19. According to the bituminous mix design by Marshall method, match the following correctly (Binder content % on x – axis)

	A		B
(i)	Marshall stability Vs Binder content%	1.	
(ii)	Flow value Vs Binder content%	2.	
(iii)	Voids% Vs Binder content%	3.	
(iv)	Voids filled with Bitumen Vs Binder content %	4.	

(A) (i – 2), (ii – 3), (iii – 4), (iv – 1)
(B) (i – 4), (ii – 2), (iii – 1), (iv – 3)
(C) (i – 3), (ii – 4), (iii – 1), (iv – 2)
(D) (i – 2), (ii – 1), (iii – 4), (iv – 3)

20. (i) Viscosity test on bitumen is done to assess the ability to be sprayed through jets.
(ii) Coating test on bitumen is done to assess the stability in presence of fines in aggregates.
(A) (i) is true and (ii) is false
(B) (i) is false and (ii) is true
(C) Both (i) and (ii) are true
(D) Both (i) and (ii) are false

21. The number of commercial vehicles in the year of completing overlay construction is estimated to be 2850 per day with an average growth rate of 6.5 percent per year, if the average *VDF* value is 5.4 and the traffic design period is 10 years. The design traffic volume if the *LDF* = 0.75 is _____.
(A) 110 msa (B) 98 msa
(C) 83 msa (D) 57 msa

22. The following data are related to a horizontal curved portion of a two lane highway: length of curve = 300 m, radius of curve = 600 m, width of pavement = 9.5 m. In order to provide an *SSD* of 80 m the set back distance of the inner lane of the pavement is
(A) 3.71 m
(B) 2.35 m
(C) 4.62 m
(D) 2.97 m

23. The speeds of overtaking and overtaken vehicles on the highways are 70 kmph and 65 kmph respectively. Assuming acceleration of overtaking vehicle as 2.5 kmph/sec and speed of vehicle in opposite direction as 65 kmph, the overtaking sight distance needed for two way traffic is (assume reaction time of driver = 2sec) _____.
(A) 451 m (B) 326 m
(C) 564 m (D) 275 m.

24. In a concrete pavement
(i) Temperature stress is tensile at bottom during day time
(ii) Load stress is compressive at the bottom.
Identify the correct choice from the following.
(A) Both the statement (A) and (B) are correct
(B) Statement (A) is correct and (B) is incorrect.
(C) Statement (B) is incorrect.and (A) is orrect
(D) Both statements (A) and (B) are incorrect

25. A valley curve is formed by a descending grade of 1 in 35 meeting an ascending grade of 1 in 30. Assuming allowable rate of change of centrifugal acceleration is 0.6 m/sec^3, design speed is 50 kmph, then the length of the valley curve to fulfill comfort condition is _____.
(A) 128 m (B) 33 m
(C) 73 m (D) 94 m

Answer Keys

1. C	**2.** C	**3.** D	**4.** C	**5.** B	**6.** A	**7.** A	**8.** D	**9.** C	**10.** A
11. A	**12.** C	**13.** B	**14.** C	**15.** B	**16.** C	**17.** A	**18.** C	**19.** D	**20.** A
21. D	**22.** A	**23.** A	**24.** A	**25.** B					

Hints and Explanations

3. $L = \dfrac{NS^2}{4.4} = \dfrac{(0.01+0.02)\times 100\times 100}{4.4} = 69$ m.

Choice (D)

4. $W_e = \dfrac{n\times \ell^2}{2\,R} + \dfrac{0.1\times V}{\sqrt{R}}$.

Where
V = design speed of road in kmph
n = no of lanes
R = Radius of the curve

$W_e = \dfrac{2\times(6)^2}{2\times 80} + \dfrac{0.1\times 65}{\sqrt{80}} = 1.17$ m Choice (C)

8. $L_S = \dfrac{V^3}{CR} = \dfrac{L}{2} = \sqrt{\dfrac{NV^3}{C}}$. Choice (D)

12. Stopping sight distance (SSD) $= vt + \dfrac{v^2}{2gf}$,

where $V = 40 \times \dfrac{5}{18} = 11.11$ m/s

$SSD = (11.11 \times 2.5) + \dfrac{(11.11)^2}{(2\times 9.8\times 0.37)}$

$\Rightarrow$ $SSD = 44.79$ m.
SSD when there is a single lane 2 way $= 2\ SSD$
$= 2 \times 44.79 = 89.59$ m. Choice (C)

13. $e + f = \dfrac{V^2}{gR} = \dfrac{V^2}{127R} \Rightarrow e + 0.1 = \dfrac{80^2}{127\times 400}$

$\Rightarrow 0.025$. Choice (B)

14. If no super elevation is provided $e = 0$

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

$f = \dfrac{80^2}{27\times 400} = 0.125$. $[\because e = 0]$ Choice (C)

15. Let $L > SSD$,

Deviation angle, $N = \dfrac{+1}{20} - \left(\dfrac{-1}{50}\right) = \dfrac{7}{100}$

$L = \dfrac{NS^2}{4.4} = \dfrac{7\times(120)^2}{4.4\times 100} = 229$m. Choice (B)

16. Length of the curve restricted to 500 m,
$L < OSD$ $(500 < 600)$

$L = 2S - \dfrac{9.6}{N} = 2\times(600) - \dfrac{9.6\times 100}{7} = 1062.8$ m.

Choice (C)

17. Radius of relative stiffness

$\ell = \left[\dfrac{Eh^3}{12k(1-\mu^2)}\right]^{\frac{1}{4}} = \left[\dfrac{3\times 10^5\times 15^3}{12\times 6\times(1-0.15^2)}\right]^{\frac{1}{4}} = 70.6$ cm.

$S_C = \dfrac{3P}{h^2}\times\left[1-\left(\dfrac{a\sqrt{2}}{\ell}\right)^{0.6}\right] = \dfrac{3\times 5100}{18^2}\left[1-\left(\dfrac{15\sqrt{2}}{70.6}\right)^{0.6}\right]$

$= 24.27$ kg/cm^2. Choice (A)

18. $X = 2.58\sqrt{aL} = 2.58\sqrt{(15\times 70.6)}$

$= 83.96 \cong 84$ cm. Choice (C)

20. Coating test is assess coating of stone aggregates.

Choice (A)

21. $N = 2650$
$r = 6.5\%$
$VDF = 5.4$
$LDF = 0.75$
$n = 10$ years

Design traffic $= 365\left\{N\times VDF\times LDF\times\dfrac{[1+r)^n - 1]}{r}\right\}$

$= \dfrac{365\times\left[2850\times 5.4\times 0.75\times\left[1.065^{10} - 1\right]\right]}{0.065}$

$= 56.8\times 10^6 \cong 57$ msa. Choice (D)

22. Set back distance $= R - (R - d)\cos\left(\dfrac{\propto}{2}\right)$

$d = \dfrac{9.5}{4}$ $\propto = \dfrac{SSD\times 180}{\Pi\times(R-d)} = \dfrac{80\times 180}{\pi\times\left(600 - \dfrac{9.5}{4}\right)} = 7.64°$

$\therefore$ Set back distance $= 600 - \left(600 - \dfrac{9.5}{4}\right)\times\cos\left(\dfrac{7.66°}{2}\right)$

$\Rightarrow$ set back distance $= 3.71$ m. Choice (A)

23. $V_b = 65$ kmph
$a = 2.5$ kmph/sec $= 0.694$ m/sec^2

$S = 0.7\ V_b + 6 = 0.7\times\left(65\times\dfrac{5}{18}\right) + 6 = 18.64$ m

$T = \sqrt{\dfrac{4S}{a}} = \sqrt{\dfrac{4\times 18.6}{0.694}}$

$= 10.36$ sec (reaction time of driver $t = 2$ sec.)
OSD $= 0.28V_b + 0.28V_bT + 2\ s + 0.28\ VT$.
$= (0.28\times 65\times 2) + (0.28\times 65\times 10.36)$
$+ (2\times 18.64) + (0.28\times 65\times 10.36)$
$= 450.78$ m $\simeq 451$ m. Choice (A)

25. $L_s = 2\left[\dfrac{Nv^3}{C}\right]^{\frac{1}{2}}$ $v = 50\times\dfrac{5}{18} = 13.88$

$N = \dfrac{1}{-35} - \dfrac{1}{30} = \dfrac{-13}{210}$

$L_s = 2\left[\dfrac{13}{210}\times\dfrac{13.88^3}{0.6}\right]^{\frac{1}{2}} = 33.2$ m. Choice (B)