



Rajasthan Public Service Commission
ASSISTANT ENGINEER EXAMINATION



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HIGHWAY

CIVIL ENGINEERING

Date of Test :15/09/2024

ANSWER KEY >

- | | | | | |
|---------|---------|---------|---------|---------|
| 1. (a) | 11. (a) | 21. (c) | 31. (b) | 41. (b) |
| 2. (c) | 12. (b) | 22. (c) | 32. (b) | 42. (c) |
| 3. (d) | 13. (a) | 23. (c) | 33. (a) | 43. (a) |
| 4. (d) | 14. (c) | 24. (b) | 34. (c) | 44. (d) |
| 5. (a) | 15. (b) | 25. (b) | 35. (d) | 45. (c) |
| 6. (d) | 16. (c) | 26. (d) | 36. (a) | 46. (d) |
| 7. (d) | 17. (c) | 27. (b) | 37. (b) | 47. (b) |
| 8. (b) | 18. (a) | 28. (d) | 38. (a) | 48. (b) |
| 9. (a) | 19. (c) | 29. (a) | 39. (a) | 49. (d) |
| 10. (c) | 20. (b) | 30. (b) | 40. (b) | 50. (b) |

Detailed Explanations

1. (a)

The camber is given a parabolic, elliptic or straight line shape in the cross-section. Parabolic or elliptic shape is given so that the profile is flat at the middle and steeper towards the edges, which is preferred by fast moving vehicles. When very flat cross slope is provided as in cement concrete pavements, straight line shape of camber may be provided.

2. (c)

3. (d)

As we know,

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

e = rate of superelevation, f = lateral friction coefficient = 0.15, V = speed of vehicle, m/s

R = radius of horizontal curve, m

g = acceleration due to gravity = 9.8 m/s²

If speed of vehicle is represented as V kmph then,

$$e + f = \frac{(0.278V)^2}{9.8R} = \frac{V^2}{127R}$$

If $f = 0$, the equilibrium superelevation required to counteract the centrifugal force fully will be given by,

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

4. (d)

85th percentile speed is upper limit of speed for regulation and 15th percentile speed is lower limit of speed for regulation.

The 98th percentile speed is the design speed.

5. (a)

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

$$\text{or } 0.08 + 0.12 = \frac{100 \times 100}{127 \times R}$$

$$\Rightarrow R = 394 \text{ m}$$

6. (d)

7. (d)

Angle parking or parallel parking may be allowed in the kerb parking. **Angle parking** may be at angle 30, 60 or 90 degrees. **Angle parking** accommodates more vehicles per unit length of kerb and maximum vehicles that can be parked is with an angle of 90 degree.

8. (b)

A bitumen emulsion is a liquid product in which a substantial amount of bitumen is suspended in a finely divided condition in an aqueous medium and stabilized by means of one or more suitable materials. The function of this emulsifier is to form a protective coating around the globules of binder resisting the coalescence of the globules.

9. (a)

$$\begin{aligned} \text{At } u &= 0, \\ k &= k_{\max} \\ u &= u_{\max} k \rightarrow 0 \end{aligned}$$

The curve (a) satisfies these conditions.

Curve (c) represents relation between density and volume of traffic.

10. (c)

$$\begin{aligned} \text{Effective green time} &= \text{Actual green time} + \text{Yellow time} - \text{lost time} \\ &= 25 + 3 - 3 \\ &= 25 \text{ seconds} \end{aligned}$$

11. (a)

$$\text{Maximum number of vehicles per hour} = \frac{1000V}{C+L}$$

12. (b)

Optimum cycle time,

$$C_0 = \frac{1.5L + 5}{1 - Y}$$

$$L = \text{Total lost time per cycle} = 16 \text{ sec}$$

$$Y = y_1 + y_2$$

$$y_1 = \frac{500}{1600} \text{ and } y_2 = \frac{300}{1600}$$

$$\therefore Y = \frac{500 + 300}{1600} = 0.5$$

$$C_0 = \frac{1.5 \times 16 + 5}{1 - 0.5} = 58 \text{ s}$$

13. (a)

Higher the GI value weaker is the soil sub-grade.

GI method is an empirical method.

14. (c)

15. (b)

Flow value is the deformation of specimen in 0.25 mm units up to the maximum load. It should be between 8 to 16.

Marshall stability value is the maximum load in kg before failure. Its minimum specified value is 340 kg. The stability first increases and then decreases with increase in bitumen content.

Unit weight also increases initially and then decreases.

Percentage of voids in total mix always decrease with increase in bitumen content.

The percentage of voids filled with bitumen increase with increase in bitumen content. But the graph is convex upward.

16. (c)

17. (c)

Traffic counters are used for traffic volume study and enoscope is used for spot speed study. Floating car method or riding check method or moving car method is used for speed and delay studies.

18. (a)

19. (c)

The pressure $3.5 \text{ N/mm}^2 = 35 \text{ kg/cm}^2$

$$\text{So, CBR} = \frac{35}{70} \times 100 = 50\%$$

20. (b)

Expansion joints are provided to allow for expansion of the slabs due to rise in slab temperature. The approximate gap width for this type of joints is from 20 to 25 mm.

21. (c)

Flexible pavements are those, which on the whole have low or negligible flexural strength and are flexible in their structural action under the loads.

The flexible pavement layers reflects the deformation of the lower layers on-to the surface of the layer. The flexible pavement layers transmit the vertical or compressive stresses to the lower layers by grain to grain transfer through the points of contact in granular structure.

22. (c)

Tie bar are not the load transferring devices. These are provided to ensure the adjacent slabs remain firmly tied together. These are provided in the transverse direction across longitudinal joints. (warping joint) at mid depth.

23. (c)

Before a highway alignment is finalised in highway project, the engineering surveys are to be carried out.

The stages of engineering surveys are :

- Map study
- Reconnaissance
- Preliminary survey
- Final location or detailed survey

24. (b)

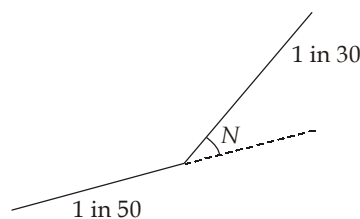
Grade compensation

$$\text{G.C.} = \left(\frac{30+R}{R} \right) \% \times \left(\frac{75}{R} \right) \% = \frac{30+50}{50} \% = 1.6\% \times \left(\frac{75}{60} \right) = 1.5\%$$

∴

$$\text{G.C.} = 1.5\%$$

25. (b)



N = Deviation angle

$$= |n_1 - n_2| = \left| \frac{1}{50} - \frac{1}{30} \right|$$

$$N = \left| \frac{3-5}{150} \right| = \left| \frac{-2}{150} \right| = \frac{1}{75}$$

26. (d)

The IRC suggests that the maximum volume of traffic that a rotary can efficiently handle is 3000 vehicles per hour entering from all the legs of the intersection.

27. (b)

The softening point is measured by the 'Ring and Ball' test.

28. (d)

The paving bitumen available in India are classified into two categories :

- (i) Paving bitumen from Assam Petroleum denoted as A-type.
- (ii) Paving bitumen from other sources denoted as S-type.

29. (a)

Benkelman beam deflection measurements is used to design the overlay thickness over flexible pavement.

30. (b)

$$\begin{aligned} \text{Rigidity factor } (R) &= \frac{\text{Contact Pressure}}{\text{Tyre Pressure}} \\ &= \frac{P_c}{P} \end{aligned}$$

31. (b)

Radius of relative stiffness

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

E = Modulus of elasticity of cement concrete

μ = Poisson's ratio of concrete

K = Modulus of subgrade reaction

h = Slab thickness

32. (b)

Ravelling is most common but easily preventable failure mode of bituminous pavements. It occurs as individual aggregates particle dislodged from the pavement surface downwards.

33. (a)

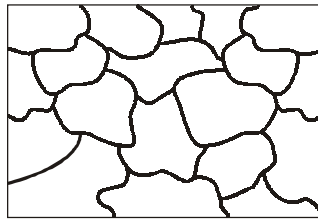
Diameter of standard plate for plate bearing test is 75 cm.

$$\begin{aligned} \text{Also,} \quad K &\propto \frac{1}{a} \\ \Rightarrow \quad K_1 a_1 &= K_2 a_2 \\ 6 \times 75 &= K_2 \times 30 \\ K_2 &= \frac{6 \times 75}{30} = 15 \text{ kg/cm}^3 \end{aligned}$$

34. (c)

For two way traffic on a right angled road intersection, the conflict points are 24 whereas, for two way traffic on T-intersection, the conflict points are 18 only.

35. (d)



Alligator cracking

Above figure shows general pattern of alligator cracking of the bituminous surface. This type of failure occurs due to repeated application of heavy wheel loads resulting fatigue or due to relative movement of pavement layer material.

Hence option (d) is correct.

36. (a)

S.No.	Type of road	Range of camber	
		Heavy rainfall	Light rainfall
1.	Cement concrete/high bituminous surface	2.0%	1.7%
2.	Thin bituminous surface	2.5%	2.0%
3.	Water bound mecadam	3.0%	2.5%
4.	Earth	4.0%	3.0%

Hence the camber for WBM should be between 2.5% – 3.0%.

Which is between $\frac{1}{40}$ to $\frac{1}{33.33}$

Hence option (a) is correct.

37. (b)

38. (a)

The Marshall stability is defined as the maximum load carried by a compacted specimen at a standard temperature of 60°C. This stability test is applicable to hot mix design of bitumen and aggregates with maximum size 2.5 cm.

39. (a)

The penetration test determines the hardness or softness of bitumen. The bitumen grade is specified in terms of penetration value. 80/100 grade bitumen means that the penetration value of bitumen is 8-10 mm at standard test conditions.

40. (b)

$$\begin{aligned} \therefore V_t &= V_s + \frac{\sigma^2}{V_s} \\ V_t &= 12 \text{ m/s} \\ V_s &= 4 \text{ m/s} \\ \therefore 12 &= 4 + \frac{\sigma^2}{4} \\ \Rightarrow \sigma^2 &= 32 \end{aligned}$$

41. (b)

Origin and destination survey are useful:

- in locating major routes of city
- locate intermediate stops of public transport
- to understand travel patterns and characteristics
- provide input to travel demand model development,
- forecasting, and planning for area wide transportation infrastructure needs and services
- monitor progress in implementing transportation policies

42. (c)

CBR test is used to evaluate the stability of soil subgrade and other flexible pavement materials. It is an arbitrary strength test and hence can not be used to evaluate the shear strength parameters. In essence it is a measure to indicate relative strengths of paving materials and not the absolute strength.

43. (a)

$$\text{Centrifugal force} = \frac{mV^2}{R} = \frac{W}{g} \cdot \frac{V^2}{R}$$

44. (d)

The main advantage of emulsion is that it can be used in wet weather even when it is raining. Also emulsions have been used in soil stabilization, particularly for the stabilization of sands in desert areas.

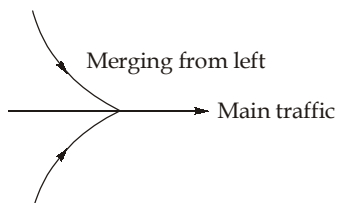
45. (c)

46. (d)

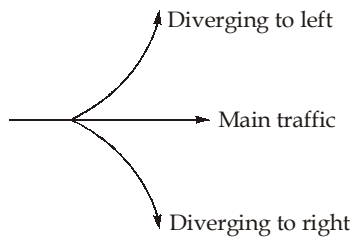
Traffic manoeuvre:

Traffic manoeuvre includes entering or leaving the roadway, making turns other than at intersection (including U-turns) and parking.

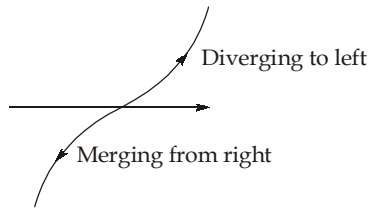
- **Merging:**



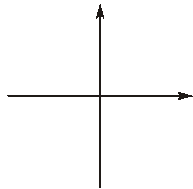
• **Diverging:**



• **Weaving:**



• **Crossing:**



47. (b)

Initial speed of vehicle

$$v = fgt$$

$$s = \frac{v^2}{2fg} = \frac{f^2 g^2 t^2}{2fg}$$

∴

$$f = \frac{2s}{gt^2} = \frac{2 \times 9.81}{9.81 \times 2^2} = 0.5$$

48. (b)

Deviation angle,

$$N = n_1 - (-n_2) = n_1 + n_2 \\ = 3\% + 5\% = 8\%$$

For

$$L > SSD,$$

$$L = \frac{NS^2}{4.4} = \frac{8}{100} \times \frac{(128)^2}{4.4} \\ = 298 \text{ m}$$

49. (d)

Length of transition curve

$$L_s = \frac{V^3}{RC} \quad (V \text{ in m/s, } R \text{ in m, } C \text{ in m/s}^3)$$

If V in km/h,

$$L_s = \frac{V^3}{(3.6)^3 RC} = \frac{V^3}{46.6CR} \approx 0.0215 V^3/CR$$

50. (b)

Toughness :

- Resistance against impact.
- Aggregate impact test is conducted.

Soundness Test :

- Resistance of aggregates against weathering action.

Strength :

- Resistance against gradual load.
- Assessed by aggregate crushing test.

Hardness :

- Resistance to abrasion (Los-Angeles' Abrasion Test)

