TEST ID: 503

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Engineering Academy

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ESE- 2019 (Prelims) - Offline Test Series Test-5

CIVIL ENGINEERING

SUBJECT: TRANSPORTATION ENGINEERING, GEO-TECHNICAL ENGINEERING AND FOUNDATION ENGINEERING

SOLUTIONS

01. Ans: (b)

Sol: Constant head permeability test is conducted on soils having good permeability. So, it is used for coarse grained soil.

02. Ans: (d)

Sol: Planning survey includes, economic studies, financial studies, traffic studies and engineering studies.

In economic studies the following details are collected

- Per capita income
- Trend of population growth
- Population and its distribution
- Agricultural and industrial products details
- Agricultural and industrial products developments
- Existing facilities on education, communication etc.

Note:

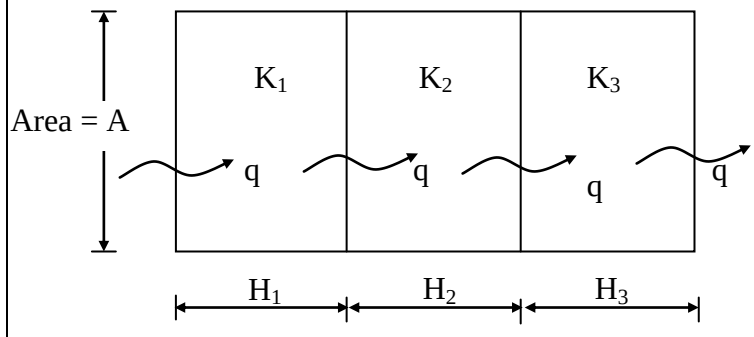
Living standards details are collected in financial studies.

Accident studies are included in traffic studies.

03. Ans: (c)

Sol: If flow is perpendicular to stratification, drainage path, head loss and hydraulic gradient are different.

Discharge or flow is same and drainage area is same.



04. Ans: (a)

Sol: $q_1 = q_2 = q$

$$\Rightarrow \frac{K_1(\Delta h_1)A}{L_1} = \frac{K_2(\Delta h_2)A}{L_2}$$

$$\Rightarrow \frac{1\times10^{-4}(0.3-0.2)}{1}A = \frac{4\times10^{-4}(0.2-x)}{2}A$$

$\Rightarrow 0.1 = 0.4 - x$

$x = 0.15m = 150$ mm

(or)

$q_2 = q_3 = q$

$$K_2\left(\frac{\Delta h_2}{L_2}\right)A = K_3\left(\frac{\Delta h_3}{L_3}\right)A$$

$$\Rightarrow \frac{4\times10^{-4}(0.2-x)}{2}A = \frac{2\times10^{-4}(x-0)}{3}A$$

$0.6 - 3x = x$

$\Rightarrow x = 0.15m = 150$ mm

05. Ans: (a)

Sol:

- Map study is done to obtain obligatory points
- Reconnaissance is done to collect various details like approximate value of gradient, length of gradient, radius of curve, Source of construction materials etc.
- Preliminary survey is done to survey various alternate alignments proposed. Aerial photographs can be used for preliminary survey where the area to be covered is vast.
- Detailed survey is done for the final alignment fixed from preliminary survey and it involves various tasks like, levelling of centre line, detailed soil survey etc.

06. Ans: (c)

Sol: Due to capillary action, pore water pressure decreases. Due to saturation, Total stress increases. Hence effective stress increases.

07. Ans: (b)

Sol: Camber can be of straight type or parabolic type or a combination of both

However for a given camber (1 in N), the value of crown is same for both straight and parabolic camber.

For straight line camber $y = W/2N$

$0.0625 = 7.5/2N$

$N = 60$

Hence camber is 1 in 60

08. Ans: (b)

Sol: In anisotropic soil, transformed section where revised scale is (horizontal) $\sqrt{\frac{K_V}{K_H}}$

So, scale for horizontal dimension

$$= \sqrt{\frac{K_V}{4K_v}} = \frac{1}{2} \ (K_H = 4\ K_V \text{ given})$$

So, AB which is originally a becomes a/2 in transformed section

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09. Ans: (c)

Sol: Grade compensation= min[(30+R)/R, 75/R] such that compensated gradient should not be less than 4%

= min (130/100, 75/100) = 0.75%

Gradient provided after grade compensation

= 4.5 – 0.75 = 3.75% < 4%

Hence grade compensation provided is 4.5 – 4 = 0.5%

10. Ans: (b)

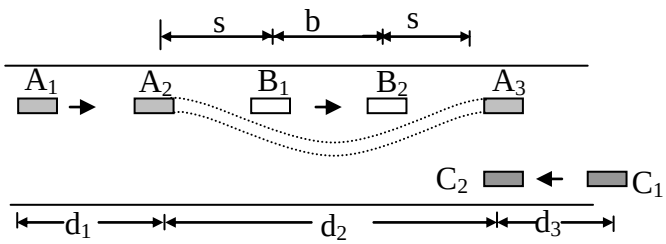
Sol: Upward seepage reduces effective stress and leads to quick sand condition.

11. Ans: (a)

Sol: Distance travelled by vehicle B during the overtaking operation is from B1 to B2 and is given by $d = v_b T$

$$T = \sqrt{\frac{4S}{a}} = \sqrt{\frac{4\times16}{1}} = 8 \text{ sec}^2$$

$d = 0.278 \times 40 \times 8 = 88.96$ m



12. Ans: (c)

Sol: 40% retained = 60% finer

D_{60} = 425 μm = 0.425 mm

Effective size = D_{10} = 0.2 mm

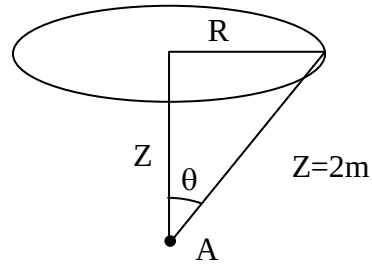
$$C_u = \frac{D_{60}}{D_{10}} = 2.125 < 6$$ (For poorly graded sand)

13. Ans: (b)

Sol: Height of object in the calculation of OSD is 1.2 m.

14. Ans: (c)

Sol:



Stress at A = 87.5 kN/m^2 = 100 (1 – cos^{3}θ)

$\Rightarrow \cos^3\theta = 0.125$

$\cos\theta = 0.5$

$\theta = 60^o$

$$\tan 60 = \frac{R}{Z} = \sqrt{3} \Rightarrow R = 2\sqrt{3}$$

Diameter = 2R = $4\sqrt{3}$

15. Ans: (c)

Sol: As per IRC specification, ruling design speed (kmph) = minimum design speed (kmph) + 16

i.e V = 84 + 16 = 100 kmph

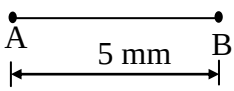
For plain terrain maximum values of e = 0.07 and f = 0.15

Ruling minimum radius of curve

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

Substituting the values $R_{rul,\ min}$ = 358 m

16. Ans: (b)

Sol: 

= depth 3 m

5 mm = 3 m

Scale is 1 : 600

17. Ans: (b)

Sol: Length of the curve L = 150 m is greater than SSD = 80 m

The distance at which the building can be constructed from the centre line of the inner lane road is set back distance.

$$m = R - (R-d)\cos\left(\frac{\alpha}{2}\right)$$

R = radius of curve = 300 m

d = distance between the centre line of road and centre line of inner lane

= (7/2) – (3.5/2) = 1.75 m

$$\frac{\alpha}{2} = \frac{S}{2(R-d)} \text{ radians}$$

Substituting the values α/2 = 0.134

Set back distance

m = 300 – (300 – 1.75) cos (0.134)

= 4.424 m

The distance from the inner edge of the road where a building can be constructed

= 4.424 –(3.5/2) = 2.68 m

18. Ans: (c)

Sol: DFS%

$$= \frac{\text{Soil volume in water} - \text{Soil volume in kerosene}}{\text{Soil volume in kerosene}} \times 100$$

$$= \frac{48-32}{32} \times 100 = 50\%$$

Degree of Expansiveness	DFS(%)
Low	< 20
Moderate	20 to 35
High	35 to 50
Very high	> 50

19. Ans: (d)

Sol: Shift of the transition curve

$$= \frac{L_S^2}{24R} = \frac{80^2}{24 \times 300} = 0.889 \text{ m}$$

Say 0.9 m

20. Ans: (d)

Sol: In over consolidated soil present effective stress is less than past effective stress.

Downward seepage and capillary action(s) increases effective stress.

Others decrease effective stress

21. Ans: (b)

Sol:

1. Clothoid or spiral: Lr = constant i.e L α (1/r)
2. Bernoullis lemniscate: Radius of curve decreases more rapidly with length. It is autogenous curve, i.e follows the path actually traced by vehicle
3. Cubic parabola: condition is x = *l* or cosϕ = *l*
4. Cubic spiral: condition is sin ϕ = ϕ

22. Ans: (d)

Sol: When loose fill is put,

Increase in total stress $\Delta\sigma = 16 \times 1.5$

$= 24\ kN/m^2$

Excess pore water pressure

$\Delta u = \Delta\sigma = 24\ kN/m^2$

Initial pore water pressure

$u_o = \gamma_w \times 1 = 10\ kN/m^2$

So, at beginning of consolidation pore water pressure = $u_o + \Delta u = 34\ kN/m^2$

At end excess pore water pressure dissipates thus pore water pressure becomes $10\ kN/m^2$.

23. Ans: (a)

Sol: Length of valley curve L = 120 m

Gradient of initial tangent of descending gradient N_1 = 1 in 25

Deviation angle N = (1/20) – (–1/25) = 0.09

Location of the deepest point from the initial tangent of descending gradient is given by

$X = N_1L/N = (1/25) \times 120/0.09 = 53.33$ m

24. Ans: (b)

Sol: Secondary consolidation takes place at end of primary consolidation. So all excess pore water pressure dissipates by that time.

25. Ans: (c)

Sol:

1. Tar is obtained by Destructive distillation of coal or wood.
2. Bitumen is obtained by Fractional distillation of petroleum.
3. When the viscosity of bitumen is reduced with volatile diluent, it is cutback bitumen.
4. Bitumen suspended in aqueous medium is called bitumen emulsion.

26. Ans: (c)

Sol: Better gradation decreases optimum moisture content (OMC) and increases dry density.

27. Ans: (a)

Sol: 30/40 implies penetration value is in the range of 30 to 40 . For hot climates low penetration value is preferred. Hence 30/40 is suitable.

28. Ans: (b)

Sol: $\frac{\Delta e}{1+e_o} = \frac{\Delta V}{V_o}$

$\frac{\Delta V}{V_o} = \frac{0.75-0.5}{1+0.75} = 0.1428$

i.e 14.28% reduction of volume

29. Ans: (b)

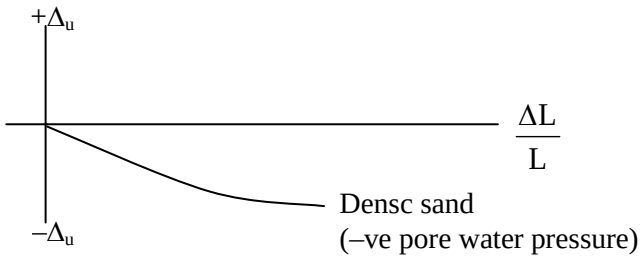
Sol: Ring and ball apparatus is used for softening point test.

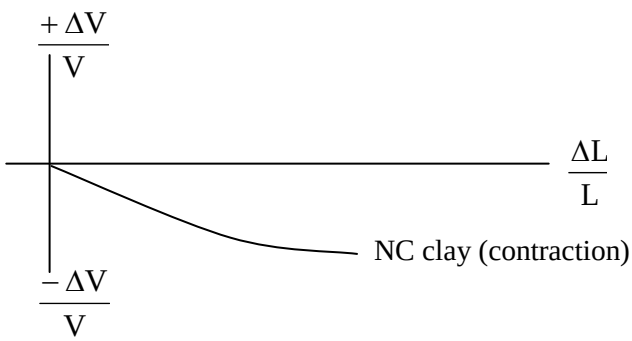
30. Ans: (a)

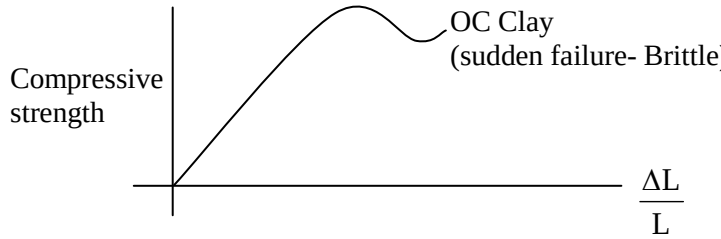
Sol: For aggregate impact test, aggregates used should be passing through 12.5 mm and retained on 10 mm sieve.

31. Ans: (b)

Sol: Loose sand are susceptible to liquefaction under earthquake loads.







32. Ans: (a)

Sol: Purely cohesive $\phi = 0$. As per Coulomb

$S = \bar{\sigma} \tan\phi + C \ (\tan\phi = 0)$

$S = C = 60$ kPa

33. Ans: (a)

Sol: Bituminous macadam is a premixed construction method in which one or more courses of compacted crushed aggregates are premixed with bituminous binder and is laid immediately after mixing.

34. Ans: (d)

Sol: $w = \left(\frac{M_2}{M_3 - M_4}\right)\left(\frac{G-1}{G}\right) - 1$

$= \frac{400}{2150-1950} \times \frac{1.5}{2.5} - 1$

$w = 0.2 = 20\%$

35. Ans: (d)

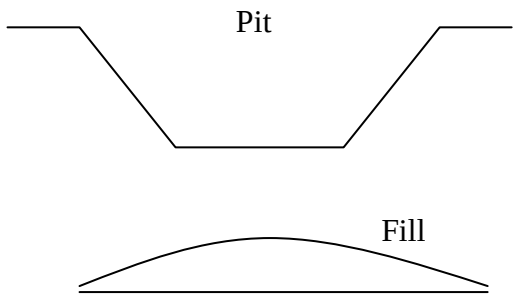
Sol: Traffic volume data can be presented in the form of

- AADT or ADT
- Trend charts

- Variation harts
- Traffic flow maps
- Volume flow diagram
- 30^{th} highest hourly volume

36. Ans: (b)

Sol:



$\gamma_{d1} = 16\ kN/m^3$

$\gamma_{d2} = 18\ kN/m^3$

$e_1 = ??$

$e_2 = 0.6$

$$\frac{\gamma_{d_1}}{\gamma_{d_2}} = \frac{1+e_2}{1+e_1}$$

$$\Rightarrow \frac{16}{18} = \frac{1.6}{1+e_1}$$

$$\Rightarrow e_1 = 0.8$$

37. Ans: (b)

Sol: Theoretical capacity = $3600/H_t$

Where H_t is the minimum time headway in seconds

= 3600/5 = 720 veh/hr

38. Ans: (c)

Sol: Water content can be more than 100%

39. Ans: (b)

Sol: Entry width of the rotary $e_1 = 7$ m

Exit width of the rotary $e_2 = 10.5$ m

Width of the weaving section

$= (e_1+e_2)/2 = (7+10.5)/2 = 8.75$ m

40. Ans: (a)

Sol: $$\frac{\gamma_d sand}{\gamma_d clay} = 1.25$$

$$\frac{G_{sand}}{1+e_{sand}} \frac{1+e_{clay}}{G_{clay}} = 1.25$$

$$\left(\frac{1+e_{clay}}{1+e_{sand}}\right) = \frac{1.25\times 2.6}{2.7} = 1.2037$$

fits this condition

41. Ans: (c)

Sol: Pedestrian green time = 7 + w/v

= 7 + 7/1.2

= 12.83 sec

42. Ans: (a)

Sol: For cohesionless soil

FOS is same irrespective of soil being dry or submerged

$$\text{FOS} = \frac{\tan\phi}{\tan i} = 1.4$$

ϕ is angle of internal friction

i is slope angle

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43. Ans: (b)

Sol: Deflection at the centre of flexible plate

$\Delta_1 = 1.5\ pa/E$

Deflection at the centre of rigid plate

$\Delta_2 = 1.18\ pa/E$

$\Delta_1/\ \Delta_2 = 1.5/1.18 = 1.27$

44. Ans: (d)

Sol: $H_C = \dfrac{C}{\gamma S_n}$

$\Rightarrow C = \gamma S_n H_C$

$= 16 \times 0.24 \times 5$

$= 19.2\ kN/m^2$

Unconfined compressive strength = 2C

$= 38.4\ kN/m^2$

45. Ans: (a)

Sol: Area of steel required (in cm^2) per metre length of longitudinal joint is given by

$A_S = \dfrac{bfhW}{100S}$

b = distance between the joint and nearest free edge in metre = 7/2 = 3.5 m

f = friction coefficient = 1.5

h = thickness of pavement in cm = 20

W = unit weight of CC pavement in kg/cu.m = 2400

S = allowable working stress in steel in kg/cm^2= 1400

Area of steel required (in cm^2) per metre length

$A_S = \dfrac{3.5 \times 1.5 \times 20 \times 2400}{100 \times 1400} = 1.8 \dfrac{cm^2}{m}$

46. Ans: (c)

Sol: Maximum height of vertical cut

$= \dfrac{4C}{\gamma\sqrt{K_a}} = \dfrac{4 \times 67.5}{18 \times 1} = 15\ m$

$K_a = 1$ (Purely cohesive)

$C = \dfrac{q_u}{2} = 67.5$

Actual height of cut = 6 m

FOS = $\dfrac{15}{6} = 2.5$

47. Ans: (c)

Sol: Reflection cracking is observed in Bituminous overlay over existing rigid pavements. Crack pattern in rigid pavement is reflected over bituminous surfacing in the same pattern.

48. Ans: (d)

Sol: Capillary saturation increases vertical effective stress thus increasing earth pressure.

Surcharge increases effective stress.

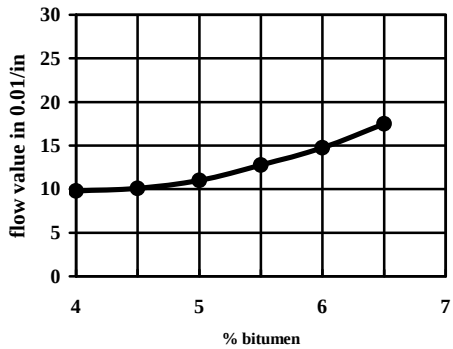
Rise of water table decreases effective stress. But increased water pressure increases overall earth pressure.

49. Ans: (a)

Sol: With increase in the bitumen content

- Flow value increases
- Stability value increases, reaches maximum and then decreases.
- Unit weight increases, reaches maximum and then decreases.

Hence, the correct option is A



50. Ans: (d)

Sol: More liquid limit more compressibility

More I_p more plastic I_P (A) = 17%

I_P (B) = 21%

A more compressible

But B more plastic

Intermediate compressibility as

$35 \le$ liquid limit ≤ 50

51. Ans: (d)

Sol: Ruling gradient is 1 in 250 = 0.4%

Grade compensation for BG track is 0.04% per degree of the curve = 2×0.04

= 0.08%

Maximum permissible gradient

= 0.4 – 0.08

= 0.32% i.e 1 in 312.5

52. Ans: (c)

Sol: $I_C = \dfrac{W_L - W_N}{I_P}$

$0.33 = \dfrac{45 - W_N}{45 - 30}$

$W_N = 40\%$

$eS = wG$

S = 1 (as water content is more then shrinkage limit)

$e = 0.4 \times 2.7 = 1.08$

53. Ans: (b)

Sol: Curve lead = 2 GN

G = 1.676 m for BG tracks

N = crossing number = 9

Curve lead = 2 GN = $2 \times 1.676 \times 9$

= 30.168 m

54. Ans: (b)

Sol: Peat forms when plant material does not fully decay in acidic and anaerobic conditions.

55. Ans: (a)

Sol: Curve resistance for a BG track

$= 0.0004WD$

W = weight of the train = 40 tonnes

D = degree of the curve = 3

Curve resistance = $0.0004 \times 40 \times 3$

$= 0.048$ tonnes

56. Ans: (b)

57. Ans: (b)

Sol: Needle beam method is used for soft soils.

58. Ans: (b)

Sol: Given

Side of square pile (s) = 40cm = 0.4m

Length of square pile (L) = 6m

Cohesion = $\frac{q_u}{2} = \frac{80}{2} = 40 kN/m^2$

Adhesion factor $, \alpha = 0.6$

Now,

Base area of pile $(A_B) = s^2 = (0.4)^2$

Surface area of pile

$$(A_S) = 4 \times s \times L = 4 \times 0.4 \times 6$$

Contribution of end bearing

$$= \frac{Q_{\text{end bearing}}}{Q_{\text{ultimate}}} = \frac{Q_{\text{End bearing}}}{Q_{\text{End bearing}} + Q_{\text{Friction}}}$$

$$= \frac{cN_cA_B}{cN_cA_B + \alpha cA_S}$$

$$= \frac{N_cA_B}{N_cA_B + \alpha A_S}$$

$$= \frac{9 \times (0.4)^2}{9 \times (0.4)^2 + 0.6 \times 4 \times 0.4 \times 6}$$

$$= \frac{9}{45} = 0.2 \Rightarrow 20\%$$

59. Ans: (b)

60. Ans: (c)

Sol: Settlement in footing on granular soil can be calculated from below empirical equation

$$\frac{S_f}{S_p} = \left(\frac{B_f(B_p + 0.3)}{B_p(B_f + 0.3)} \right)^2$$

$$\frac{S_f}{18} = \left(\frac{1.5(0.3 + 0.3)}{0.3(1.5 + 0.3)} \right)^2$$

S_f = 50mm

61. Ans: (d)

Sol: Approach surface is the imaginary surface at the end of landing and diverging away with upgrade. It is trapezoidal in shape and longitudinally centred on the extended centre line of runway.

Take off climb surface is similar to approach surface provided at the take off end of runway.

62. Ans: (c)

Sol: Observed SPT value $N_0 = 20+25 = 45$

If over burden pressure ≤ 280 kN/m^2

Correction for overburden

$$N_1 = N_0 \times \left(\frac{350}{\bar{\sigma}+70}\right)$$

$$= 45 \times \left(\frac{350}{210+70}\right) = 56.25 \simeq 56$$

Final corrected SPT value

$$N = 15 + \left(\frac{N_1 - 15}{2}\right) = 15 + \left(\frac{56-15}{2}\right)$$

$$= 35.5 \simeq 36$$

63. Ans: (a)

Sol: Woven geotextiles usually exhibit higher strength and lower elongation in comparison to non woven geotextiles.

64. Ans: (c)

Sol: $\frac{D_f}{B} = \frac{3}{3} = 1$

When $0 < \frac{D_f}{B} < 2.5$

$$N_C = 6 \times \left(1 + 0.2 \times \frac{3}{3}\right) = 7.2$$

$$C = \frac{q_u}{2} = \frac{100}{2} = 50 \text{ kN/m}^2$$

According to skempton $q_{nu} = C.N_c$

$= 7.2 \times 50$

$= 360$ kN

$$q_s = \frac{q_{nu}}{FOS} + \gamma.D_f = \frac{360}{3} + 20 \times 3$$

$= 180$ kN/m^2

65. Ans: (c)

Sol: $H = 4$ m

$\Delta\sigma^{-1} = 50$ kPa

$C_v = 1.25$ m^2/year

$k = 0.025$ m/years

$S_f = m_v H. \Delta \sigma'$

$$m_v = \frac{k}{c_v \gamma_w} = \frac{0.025}{1.25 \times 10} = 2 \times 10^{-3} \text{ m}^2/\text{kN}$$

$S_f = 2 \times 10^{-3} \times 4 \times 50 = 0.4$ m

$\therefore$ At 50% consolidation $= 0.5 \times 0.4 = 0.2$ m

66. Ans: (a)

Sol: Track circuit is a device, which is used to detect the presence of trains on the track. Since concrete is a bad conductor of electricity, prestressed concrete sleepers can be used for track circuiting. Hence both the statements are correct and statement II is the correct explanation of statement I.

67. Ans: (a)

68. Ans: (c)

Sol: Cross wind component interrupts the runway taking and landing operations.

Hence it should be minimum. Head wing component produces greater lift during take off operations.

Hence, statement (II) is wrong.

69. Ans: (c)

70. Ans: (d)

Sol: Since the pressure of the wheel acts on the inner edge of the rail, there is heavy wear and tear of the rail. Also due to eccentricity of loading, lateral bending stresses are induced which causes damage to the sleepers. Hence to reduce these effects, the rails are tilted at an angle (generally 1 in 20) inwards.

Hence statement I is wrong.

71. Ans: (d)

Sol: IS:2911 recommends the minimum spacing of piles as

3 × diameter of piles ----- for friction piles

2.5 × diameter of piles ---- for end bearing piles.

So, Statement (I) is false.

72. Ans: (b)

Sol: Basic capacity is the maximum number of PCUs that can pass a given point in one hour under ideal road and traffic conditions.. Since, for two roads with same physical features basic capacity is same as traffic conditions are assumed to be ideal.

Possible capacity is the maximum number of PCUs that can pass a given point in one hour under prevailing road and traffic conditions. Hence in the worst case, when the prevailing traffic condition is ba due to traffic congestion it can be zero. In ideal conditions it can be basic capacity.

Hence both the statements are correct.

73. Ans: (d)

Sol: Statement (I) is wrong

Although Boussinesq theory is applied to isotropic soils which is not found in layered soil, still it is used as it gives higher stress value thus leading to conservative design.

74. Ans: (c)

Sol: Mastic asphalt is a mixture of bitumen, fine aggregates and filler in suitable proportions resulting in a voidless and impermeable mass. It can absorb vibrations and has the property of self healing of cracks without bleeding. Hence it is suitable for surfacing of bridge deck slabs.

Hence statement II is wrong.

75. Ans: (a)

Sol: Advantage of vertical drains

i. Expediting the rate of settlement by shortening the drainage path.
ii. Accelerate the rate of consolidation
iii. Acceleration in the rate of gain in shear strength.

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AIR 2 —  PUNIT SINGH CE

AIR 2 —  CHIRAG SINGLA ME

AIR 3 —  RAMESH KAMULLA E&T

AIR 3 —  SRIJAN VARMA EE

AIR 3 —  PRAVEEN KUMAR CE

AIR 3 —  MAYUR PATIL ME

AIR 4 —  JAPJIT SINGH E&T

AIR 4 —  ANKIT GARG EE

AIR 4 —  AMIT KUMAR ME

AIR 5 —  NARENDRA KUMAR E&T

AIR 5 —  KARTHIK KOTTURU EE

AIR 5 —  RISHABH DUTT CE

AIR 5 —  VITTHAL PANDEY ME

AIR 6 —  KUMUD JINDAL E&T

AIR 6 —  RATIPALLI NAGESWAR EE

AIR 7 —  KARTIKEYA DUTTA E&T

AIR 7 —  TEKCHAND DESHWAL EE

AIR 7 —  ROHIT KUMAR CE

AIR 8 —  SURYASH GAUTAM E&T

AIR 8 —  RAVI TEJA MANNE EE

AIR 8 —  VIJAYA NANDAN CE

AIR 8 —  ROHIT BANSAL ME

AIR 9 —  SHANAVAS CP E&T

AIR 9 —  SOUVIK DEB ROY EE

AIR 9 —  ROOPESH MITTAL CE

AIR 10 —  PRATHAMESH E&T

AIR 10 —  MILAN KRISHNA EE

AIR 10 —  SRICHAND POONIYA CE

TOTAL SELECTIONS in Top 10	34

	TOP 10
E&T	10
EE	10
CE	8
ME	6

and many more...

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