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ESE- 2018 (Prelims) - Offline Test Series Test-7

CIVIL ENGINEERING

SUBJECT: GEO-TECHNICAL AND FOUNDATION ENGINEERING + TRANSPORTATION ENGINEERING

SOLUTIONS

01. Ans: (d)

02. Ans: (a)

Sol: Emperical constant (C) for drop hammer

= 2.5

For single acting steam hammer = 0.25

It doesn't take into account the reduce bearing capacity of pile when in group.

03. Ans: (b)

Sol: $\rho_{bulk} = \rho_d(1+w) = \left(\frac{G\rho_w}{1+e}\right)(1+w)$

$$2 = \left(\frac{2.65\times1}{1+e}\right)(1+0.2)$$

Ĝ $1+e = \frac{2.65\times1.2}{2} = 1.59$

e = 0.59

We know

$e.S_r = G.W$

Degree of saturation,

$$S_r = \frac{2.65\times0.2}{0.59} = 89.83\%$$

04. Ans: (d)

05. Ans: (a)

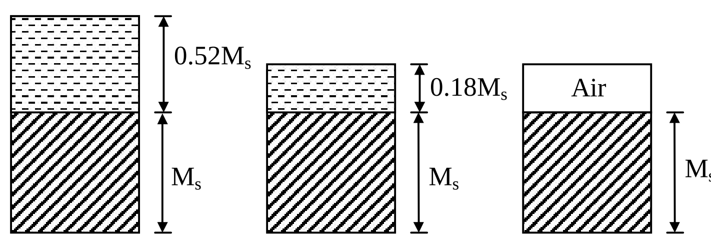
Sol: Linear shrinkage

$$(L_s) = 100\left(1-\left(\frac{100}{V_s+100}\right)^{1/3}\right)$$

If $V_s\uparrow$ L_s also $\uparrow$

06. Ans: (c)

Sol:



1) at liquid limit ($40\ cm^3$)   2) at shrinkage limit ($25\ cm^3$)   3) at dry state

∴ Difference of volume of water in 1 & 2 is = (40 – 25) = 15 cm^3 = 15 gm

But this is also equal to

$(0.52\ M_s - 0.18\ M_s)$

∴ $(0.52 - 0.18)\ M_s = 15$ gm

$M_s = 44.1$ gm

07. Ans: (d)

08. Ans: (a)

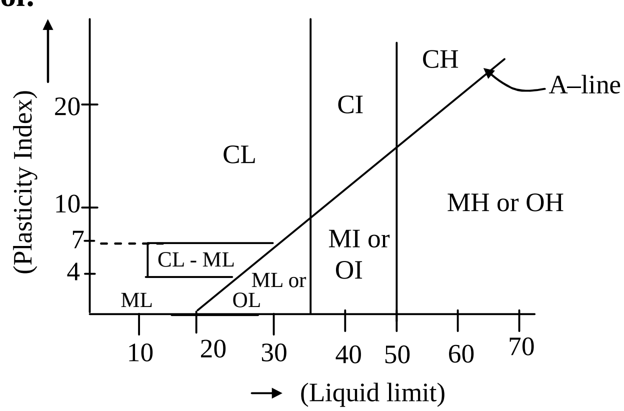
Sol: 1. Pipette method and hydrometer methods are standard laboratory methods.

2. Meniscus correction is always positive $(+C_m)$.

09. Ans: (a)

10. Ans: (b)

Sol:



Plasticity Chart

A-line equation is used since the soil is fine grained

⇒ A-line = $0.73 \times (w_L - 20)$

$= 0.73 \times (25 - 20)$

= 3.65%

$I_p = W_{LL} - W_{PL}$

= 25 – 20 = 5%

I_p > A-line

But

$4 < I_p < 7$

∴ Soil is classified as CL-ML

11. Ans: (b)

Sol: $Q_a = \dfrac{WH}{F(S+C)} \Rightarrow W = 20$ kN,

H = 1.0 × 100 = 100 cm

S = 5 mm = 0.5 cm,

C = 2.5 cm for drop hammer

$= \dfrac{20 \times 100}{6(0.5+2.5)} = 111.1$ kN

12. Ans: (b)

Sol:

1. Structural water is held by the crystalline structure of soil.

2. In capillary saturation zone, water is under tension not soil.

13. Ans: (b)

Sol:

Mass of water = M_w = 1624 – 1300

= 324 kg

Volume of water $= \dfrac{324}{1000} = 0.324\,\text{m}^3$

Mass of solids = M_s =1300 kg

$$V_s = \frac{M_s}{G.\rho_w} = \frac{1300}{2.65\times1000} = 0.490\,\text{m}^3$$

$\therefore$ Volume of air $V_a = 1 - V_w - V_s$

= 1 – 0.324 – 0.490

= 0.186 m^3

14. Ans: (b)

Sol: "Capillary siphoning" causes upstream water to flow towards down stream if the height of impervious core is not sufficiently above the H.F.L.

15. Ans: (b)

Sol: $K = \frac{\gamma_w}{\mu}$

$$\frac{K_1}{K_2} = \frac{(\gamma_w)_1}{(\gamma_w)_2} \times \frac{\mu_2}{\mu_1}$$

$$\therefore \frac{K_1}{K_2} = \frac{\gamma_{w_1}}{0.97\gamma_{w_1}} \times \frac{0.75\mu_1}{\mu_1}$$

$$\frac{K_1}{K_2} = \frac{0.75}{0.97} \Rightarrow K_2 = 1.29\ K_1$$

16. Ans: (b)

Sol: We know

Q = k.i.A

Seepage velocity, $V_s = \frac{V}{n}$

V = average velocity = k.i

$$\therefore \quad k.i = \frac{Q}{A} = \frac{\left(\frac{450\,cm^3}{10\,min}\right)}{50\,cm^2}$$

$$\Rightarrow \quad v == k.i = \frac{45}{50}\ cm/\ min$$

$$v_s = \frac{v}{n} = \frac{45}{50x0.4}$$

$= 2.25$ cm/ min

17. Ans: (b)

Sol: Quick sand starts occurring at critical gradient

$$i_c = \frac{G-1}{1+e}$$

$$= \frac{2.7-1}{1+0.7}$$

$= 1$

$(\therefore i_c = h/z = 1\ ;\ h = z)$

18. Ans: (c)

Sol: Radial stress $(\sigma_R) = \frac{3Q}{2\pi} \times \frac{\cos\phi}{R^2}$

$\Rightarrow \quad \sigma_R \propto \frac{1}{R^2}$ inversely proportional

19. Ans: (a)

Sol: 1. It is more accurate than the equivalent point load method

20. Ans: (a)

Sol: 1. In floating type, specimen is compressed towards middle by both top and bottom porous stones.

2. Direct measurement of permeability is possible with fixed ring consolidometer.

21. Ans: (a)

Sol: $T_v = \frac{C_v \times t}{d^2}$

$$t = \frac{T_v \times d^2}{C_v}$$

$$t = \frac{0.197 \times 1}{17.28 \times 10^{-4}}\ \text{days}$$

t = 114 days

22. Ans: (c)

Sol: It is governed by plastic readjustment of soil particles not by dissipation of excess pressure

23. Ans: (d)

24. Ans: (d)

Sol: $S = C' + \sigma' \tan\phi'$

Cohesion less soil $\therefore C' = 0$

$$\sigma' = \gamma.H \Rightarrow \gamma = \frac{G.\gamma_w}{1+e}(1+w) = \frac{2.7\times10}{1+0.5}(1+w)$$

$$w = \frac{e.S_r}{G} = \frac{0.5\times0.5}{2.7} = 0.0926$$

$$\therefore \quad \gamma = \frac{27}{1.5}\times1.0926 = 19.67\,\text{kN/m}^2$$

$$\therefore \quad S = 0 + (19.67\times3)\tan30°$$

$$= 34.06\ \text{kN/m}^2$$

Try to approximate the calculations don't stress on digits/decimals

25. Ans: (a)

Sol: $\alpha_f = 45 + \phi/2 \Rightarrow 60° = 45 + \phi/2$

$\phi = 30\ °$

Also, $\sigma_1 = \sigma_3 \tan^2\alpha_f + 2\,C\tan\alpha$

$\Rightarrow \quad 2(\text{kg/cm}^2) = 2\times C\times\tan60°$

$$C = \frac{2}{2\tan60°} = \frac{1}{\sqrt{3}}\,\text{kg/cm}^2$$

$C = 0.577\ \text{kg/cm}^2$

26. Ans: (c)

Sol:

1. Sliding wedge moves outward in case of active earth pressure.
2. The critical slip surface is that for which the wall reaction is maximum i.e. the wall must resist the maximum lateral pressure before it moves away from the fill in the case of active case.

27. Ans: (d)

Sol: Total pressure $(P) = \sqrt{P_1^2 + w^2}$

w = weight of ABC = 100 kN/m

P_1 = active thrust on vertical face BC

$= \frac{1}{2} K_a . \gamma . H^2$

$= 1/2 \times 0.4 \times 20 \times 4^2$ kN/m = 64 kN/m

$\therefore P = \sqrt{64^2 + 100^2}$

= 118.76 kN/m

28. Ans: (a)

Sol: 1. Bulkhead is generally flexible and composed of a single row of partially embedded sheet piles with external supports.

2. It is subjected to both active and passive earth pressure.

29. Ans: (d)

Sol: $F = \frac{\tau_c}{\tau} = \frac{\tan\phi}{\tan i} = \frac{\tan 30°}{\tan 12°} = 2.72$

30. Ans: (a)

Sol: $\phi_w = \frac{\gamma'}{\gamma_{sat}} \times \phi$

$\gamma_{sat} = \left(\frac{G+e}{1+e}\right)\gamma_w = \frac{2.7+0.8}{1.8} \times 10$

$\gamma_{sat} = 19.44$ kN/m^3

$\gamma' = 19.44 - 10 = 9.44$ kN/m^3

$\Rightarrow \phi_w = \frac{9.44}{19.44} \times 15$

$\therefore \phi_w = 7.28°$

31. Ans: (a)

Sol:

1. Taylor's stability number gives factor of safety with respect to cohesion only.
2. Friction circle with minimum F.O.S is the critical circle.

32. Ans: (a)

Sol:

1. Culmman's method is suitable for very steep slopes
2. Face failure, toe failures are part of slope failures.

33. Ans: (d)

Sol: $D_{min} = \frac{q}{\gamma}\left(\frac{1-\sin\phi}{1+\sin\phi}\right)^2$

$D_{min} = \frac{36}{18}\left(\frac{1-\sin 30°}{1+\sin 30°}\right)^2 = \frac{36}{18} \times \frac{1}{9}$

$D_{min} = 0.22$ m

34. Ans: (a)

Sol:

1. Failure is not sudden, it is defined by large settlements.
2. Slight bulging is observed.

35. Ans: (a)

36. Ans: (d)

Sol: Scale distance represents the depth

$\therefore$ 5 cm = 3 m

$1 \text{ cm} = \frac{300}{5} \text{ cm}$

1 cm = 60 cm

$\therefore$ Scale is 1 in 60

37. Ans: (b)

Sol:

In the Meyerhof's method effective width is determined.

$B' = B - 2\, e_x$

$e_x = \mu/P$

38. Ans: (c)

Sol: When D = 0 (D = depth of footing)

$N_c = 6.20$ for square (or) circular footing

= 5.14 for strip footing

$q_{nu} = CN_c = 30 \times 6.20 = 186 \text{ kN/m}^2$

$$q_{ns} = \frac{q_{nu}}{F.O.S} = \frac{186}{3} = 62 \text{ kN/m}^2$$

39. Ans: (d)

Sol: For square footing

$q_u = 1.3\, CNc + \gamma .D.Nq + 0.4 \times \gamma \times B \times N\gamma$

40. Ans: (d)

41. Ans: (a)

Sol: Capacity of lane, $C = S\frac{g_i}{C_o}$

g_i is effective green time

$g_i = G + A - T_L$

= 25 + 3 – 3 = 25 seconds

$$C = 2000 \times \frac{25}{60} = 833 \text{ veh/hr/lane}$$

42. Ans: (d)

Sol: It is assumed that vehicle has only 50% brake efficiency.

If frictional resistance between tyre and road is more then stopping distance required will be less

43. Ans: (a)

Sol: Work done against friction in stopping the vehicle is

$Fl = f\, w\, l$

$4000 = 0.35 \times w$

= 11428 N

44. Ans: (b)

Sol: Distance covered by slow moving vehicle is v_bT

Overtaking time $T = \sqrt{\frac{2(S_1 + S_2)}{a}}$

$$T = \sqrt{\frac{2(50+50)}{1}} = 14.14 \text{ sec}$$

$v_bT = 15 \times 14.14 = 212$ m

45. Ans: (c)

Sol: Radius of transition curve is infinite at straight edge and changes to R at curve point

46. Ans: (b)

47. Ans: (a)

Sol:

Tractive force available = T cosθ

$$= \frac{\sqrt{3}}{2} T$$

48. Ans: (a)

49. Ans: (a)

Sol: Grade compensation $\frac{30+R}{R}$ or $\frac{75}{R}$

1.15% (or) 0.375%

Use minimum value i.e. 0.375%

After grade compensation, the gradient is

= 5.5 – 0.375

= 5.125%

50. Ans: (c)

Sol: According to IRC standards, the length of horizontal transition curve should not be less than the value given by the empirical formula for the mountainous terrain.

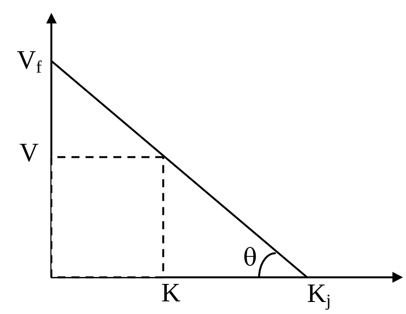
Transition length in case of mountainous terrain according to empirical formula is

$$L_s = \frac{V^2}{R} = \frac{90^2}{200} = 40.5 \text{ m}$$

∴ According to IRC standards, the length of horizontal transition curve should not be less than the value given by the empirical formula for the mountainous terrain i.e. 40.5 m.

51. Ans: (b)

Sol: The equation for speed density relationship is



$$\tan\theta = \frac{V_f}{K_j} = \frac{V}{K_j - K}$$

$$V = V_f - \left(\frac{V_f}{K_j}\right)K$$

$$V = 40 - \frac{V_f}{200} \times 50$$

Sub $V_f = 40$

$$V = 40 - \frac{40}{200} \times 50 = 30 \text{ kmph}$$

52. Ans: (b)

Sol:

Registration death rate can be calculated as follows

$$R = \frac{B \times 10000}{m}$$

R is death rate per 10000 vehicles registered

B is motor vehicle fatalities

m is motor vehicles registered

$$F = \frac{4000 \times 10,000}{6,000,000} = 6.7 \simeq 7$$

53. Ans: (a)

Sol: In this model speed tends to infinity when density tends to zero so it is unable to predict the speeds at lower densities.

54. Ans: (a)

55. Ans: (c)

Sol: Vertical compressive strain on the subgrade is considered as a failure criteria to reduce permanent deformation.

56. Ans: (b)

Sol: Flexible plate:

Modulus of elasticity of soil, $E_s = \frac{1.5\ Pa}{\delta}$

a is radius of the plate

δ is maximum vertical deflection

P is pressure on the plate

$$110 \times 10^3 = \frac{1.5 \times 75 \times 500}{\delta \times 2}$$

δ = 0.25 cm = 2.5 mm

57. Ans: (b)

Sol: % of air voids

$$= \frac{\text{Bulk volume} - \text{Theoretical volume}}{\text{Bulk volume of mix}} \times 100$$

= 7.5%

58. Ans: (d)

59. Ans: (a)

Sol: Sleeper density is n + 5

n is rail length, for B.G. it is 12.80 m

Sleeper density = n + 5 = 12.8 + 5

= 17.8 ≃ 18 sleepers

Total number of rails $= \frac{38}{12.8} \simeq 3$ rails

Total number of sleepers = 3 × 18

= 54 sleepers

60. Ans: (c)

Sol: Radius $R = \frac{V^2}{125f} = \frac{60^2}{125 \times 0.13} = 221\ m$

61. Ans: (c) **62. Ans: (b)**

63. Ans: (d)

Sol: Dowel bars are usually placed across transverse joint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64. Ans: (d)

Sol: The paved area adjacent to terminal building and hangers used for loading and unloading, servicing and parking of aircraft is apron.

65. Ans: (a)

Sol: From relation of time mean and space mean speed

$$V_t = V_s + \frac{\sigma^2}{V_s}$$

Standard deviation = 0

$V_t = V_s$

66. Ans: (a)

67. Ans: (d)

Sol: As compared air is forced to prevent the entry of water in "lower chamber", it permits excavation in dry state.

68. Ans: (d)

Sol: Compaction increases soil strength in driving operation which in turn increase the strength of pile.

69. Ans: (a)

70. Ans: (b)

Sol: Cheap roads involves ground improvement with locally available materials using compaction.

71. Ans: (d)

Sol:

Amount of cement needed is proportional to the surface area and thickness

∴ Clays and silt need more cement than gravels

$$\left.\begin{array}{l}\text{Gravel}: 5 \text{ to } 10\% \\ \text{Silt}: 7 \text{ to } 12\% \\ \text{Clays}: 12 \text{ to } 20\%\end{array}\right\}\text{Cement needed}$$

72. Ans: (c)

Sol: The reinforcing action is achieved by the surface friction between the fabric and soil fill.

The reason is correct for geogrids.

73. Ans: (d)

Sol: The stress distribution on the failure plane is uniform as the cell pressure is maintained constant around the soil mass.

74. Ans: (a)

75. Ans: (a)

Sol: In case of deep formations, shear strength is mobilized/developed on the sides also.

Ex. Pile foundations (floating piles)