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ESE- 2018 (Prelims) - Offline Test Series **Test-19**

CIVIL ENGINEERING

SUBJECT: ENVIRONMENTAL ENGINEERING + GEO-TECHNICAL AND FOUNDATION ENGINEERING + TRANSPORTATION ENGINEERING

SOLUTIONS

01. Ans: (a)

Sol: Height of crown $= \frac{w}{2n}$

$$\frac{7.5}{100} = \frac{9}{2n}$$

$$\frac{1}{n} = \frac{1}{60}$$

02. Ans: (c)

03. Ans: (b)

Sol: Trickling filter comes under Aerobic biological process.

04. Ans: (a)

Sol: Sludge thickening is the process in which sludge volume is decreased by increasing the concentration of solids by reducing moisture content.

05. Ans: (b)

Sol:

$$x_o = 225\left(\frac{mg}{L}\right).1570\frac{m^3}{h}\times 1000\frac{L}{m^3}\times 10^{-6}\frac{kg}{mg}$$

$x_o = 353$ kg/hr

$\therefore$ Raw sludge produced is $= 0.6 \times 353$

$= 212$ kg/hr

06. Ans: (d)

Sol:

The statements are exactly opposite

If the sludge is to be thickened by gravity, its settling and compaction rates are important. On the other hand, if the sludge is to be digested anaerobically, the concentration of volatile compounds other organic solids are important.

07. Ans: (c)

Sol:

The main disadvantage of RCC pipes are

1. They are likely to get corroded by ground water due to presence of acids, alkalis (or) sulphur compounds.
2. They cannot withstand very high pressure.
3. They tend to leak due to shrinkage cracks and porosity.

08. Ans: (d)

Sol:

Since surface water is highly polluted → Aeration is done to kill algae, we use $CuSO_4$ and Cl_2 → So prechlorination is done before Aeration.

After aeration flocculation & sedimentation is done when we use slow sand filters in treatment of water, coagulation and flocculation will never be used prior to it.

So use rapid sand filter.

Since prechlorination is done, post chlorination is done before supply.

∴ Correct sequence is

Prechlorination → Aeration → Flocculation & sedimentation → Rapid sand filtration → Disinfection (post chlorination) → Supply.

09. Ans: (d)

Sol:

In cascade aerator, surface area of liquid exposed is rather limited and there is a loss of efficiency. Hence only 20-45% of CO_2 and 35% H_2S is removed where as in spray towers (or) nozzle removes 90% CO_2 & 99% H_2S only of the limitation of aeration is, it is not efficient in removal of taste and odour caused by chemicals, non-volatile substance like oil and Grease.

10. Ans: (b)

Sol:

1 ml of 0.02 N EDTA used is measures 1 mg of hardness of $CaCO_3$

$\therefore$ Hardness of mg/*l* as $CaCO_3$

$$= \frac{\text{m}\ell \text{ of } 0.02\text{N EDTA titrant}}{\text{volume of sample (m}\ell)} \times 1000$$

$$= \frac{70}{500} \times 1000$$

= 140 mg/*l* as $CaCO_3$

11. Ans: (c)

Sol:

Statement-II is wrong.

Requirement of chlorine increases with decrease in temperature because Bacteriocidal activity will be more at higher temperature and fastly reacts with chlorine and dies. If temperature is less then more chlorine is required.

Chloramines are weaker disinfectant (25times less than the chlorine). So forming chloramines reduces efficiency in killing bacteria.

12. Ans: (b)

Sol:

Radial system $\rightarrow$ Flow from centre to periphery

Circular system $\rightarrow$ Main lines are laid along the periphery covering in entire area

Grid iron system $\rightarrow$ Large number of cut off value and longer pipe lengths are required

Tree System $\rightarrow$ Calculations are simple and accurate flow determination is also possible at any line.

13. Ans: (a)

Sol:

$P^{OH} = -\log[OH^-]$

Where $[OH^-]$ is the concentration of OH^- ions in moles per litre

$$\text{Moles} = \frac{\text{weight in gm}}{\text{molecular mass}} = \frac{34 \times 10^{-3}}{17}$$

$\therefore$ Moles of $OH^- = 2 \times 10^{-3}$

$P^{OH} = -\log(2 \times 10^{-3}) = -[\log(2) + \log(10^{-3})]$

$= -0.300 + 3$

$= 2.7$

$\therefore P^H + P^{OH} = 14 \Rightarrow pH = 14 - 2.7 = 11.3$

14. Ans: (b)

Sol:

SO_2 in $\mu g/m^3$

$$= \frac{SO_2 \text{ in ppm} \times \text{molecular wt. of } SO_2 \times 1000}{24}$$

$$= \frac{0.6 \times 64 \times 1000}{24}$$

$= 1600$

15. Ans: (c)

Sol:

The main demerits of gravitational settling chamber is requires large space and collector efficiency in low only larger sized particle are separated out (usually > 70 μm)

Wet scrubbers are better than centrifugal collectors.

In wet scrubbers efficiency can go upto 99% where as in centrifugal collectors efficiency is 50-90%.

Electrostatic precipator use high voltage, so they may pose risk to personal safety of the staff.

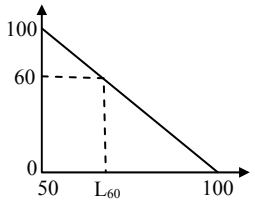
16. Ans: (c)

Sol:

In a sanitary landfills, there is no production of gases SO_2 & NO_2.

17. Ans: : (b)

Sol:



Using similar triangles concept

$$\frac{100-0}{100-60} = \frac{100-50}{L_{60}-50}$$

$$\frac{100}{40} = \frac{50}{L_{60}-50}$$

$L_{60} - 50 = 20$

$L_{60} = 70$ dB

18. Ans: (d)

Sol:

The production of sludges requires

$$= \frac{1500 \text{ kg/day}}{3 \text{ kg/m}^3 - \text{day}}$$

$= 500 \text{ m}^3$ digestor volume

The total mass of wet sludge pumped to the digestor is $= \frac{1500 \text{ kg/day}}{0.04} = 37500$ kg/day

Since 1L of sludge weighs about 1 kg, the volume of sludge is 37500 L/day (or) 37.5 m^3/day

$\therefore$ Hydraulic retention time $= \frac{V}{Q}$

$$= \frac{500 \text{ m}^3}{375 \text{ m}^3/\text{day}}$$

$= 13.3$ days

19. Ans: (a)

Sol:

Total hardness to be left = 80 mg/*l*

Carbonate hardness to be left = 35 mg/*l*

∴ Non-carbonate hardness to be left

= 80 – 35 = 45 mg/*l*

Non-carbonate hardness of raw water = 92 mg/*l*

∴ Non-carbonate hardness to be removed from raw water = 92 – 45 = 47 mg/*l*

100 mg/*l* of $CaCO_3$ (NCH) requires 106 mg/*l* of Na_2CO_3 (soda)

∴ 47 mg/*l* of $CaCO_3$ will require $= \frac{106}{100} \times 47$

= 49.8 mg/*l*

∴ Soda required for 1 m*l* of water = 49.8 × 1

= 49.8 kg

20. Ans: (d)

21. Ans: (a)

Sol:

Centrifugal force generated $F_c = M_p . \frac{V_1^2}{R}$

$F_c \alpha \frac{1}{R}$

Hence decrease in R will increase F_c and consequently increase the efficiency of dust collection.

22. Ans: (c)

Sol:

More land area is required in standard trickling filter as the filter loading is less and less area is required in high rate filters.

Type of effluent produced in standard filter is highly nitrified and stabilised with BOD effluent ≤ 20 ppm but in high rate filters effluent is nitrified upto nitrate stage and thus less stable and hence it is of slightly interior quality, BOD effluent ≥ 30 ppm.

Quality of secondary sludge produced in standard rate filter is black highly oxidised with slight fine particles.

23. Ans: (c)

Sol:

1. The compactive effort of modified proctor test is 4.55 times of standard proctor test.
2. The permeability decreases in case of wet optimum side and increases in dry optimum side.

24. Ans: (d)

Sol:

1. Thixotropy is the phenomenon of regaining of lost strength with passage of time, with no change in water content
2. Absorbed water imparts plasticity to clay

25. Ans: (c)

26. Ans: (a)

27. Ans: (b)

Sol:

It is observed in granular soils also.

28. Ans: (b)

Sol:

For a raft on clayey soil for $\frac{D_t}{B}=\frac{5}{10}<2.5$

$$q_{nu}=5\left(1+0.2\frac{D_f}{B}\right)\left(1+0.2\frac{B}{L}\right)\times C_u$$

$$=5\left(1+0.2\times\frac{5}{10}\right)\left(1+0.2\times\frac{10}{10}\right)\times 40$$

$$q_{nu}=264\ kN/m^2$$

$$q_{ns}=\frac{264}{2.5}=105.6\,kN/m^2$$

29. Ans: (d)

Sol:

Most of the times 1st symbol would be of coarses size.

$\therefore$ It is SC-CL

30. Ans: (b)

Sol:

1. Consolidation is nothing but a process of remoulding which gives dispersed structure.

2. Coarse gained soils are mainly under the influence of gravitational forces. The surface forces are less dominant.

31. Ans: (c)

Sol:

$R_e \leq 1$ then Darcy's law is valid

32. Ans: (a)

33. Ans: (b)

Sol:

$Q_c = k.i_c.A$

Let's take unit surface area then,

$Q_c = k.\ i_c \quad m^3/sec/m^2$

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

$G = 2.5$

$\therefore\ Q_c = 3 \times 10^{-7} \times (2.5-1) \times (1-0.4)$

$= 2.7 \times 10^{-7}\ m^3/sec/m^2$

34. Ans: (d) **35. Ans: (a)**

36. Ans: (c)

Sol:

1. It is applicable for C-ϕ soils also
2. Failure surface is an area of circle
3. It considers the effect of tension crack.
4. It uses Coulomb's equation to find shear strength.

37. Ans: (c)

Sol:

Percolation should be maximum at D.S slope for critical state.

38. Ans: (a)

Sol:

Failure is sudden in general shear failure.

39. Ans: (b)

Sol:

For flexible pavement

$$\delta = \frac{1.5Pa}{E_s}$$

$$= \frac{1.5 \times 0.5 \times 75/2}{20}$$

$\delta = 1.4\ cm = 14\ cm$

40. Ans: (c)

Sol:

We know, $w = \dfrac{\text{mass of water}}{\text{mass of solids}}$

As it is said in the question mass of water is kept constant.

Also mass of solids will remain constant.

$\therefore$ w is constant

$$S_r = \frac{wG}{e}$$

$$\therefore\ S_1 = \frac{wG}{e_1} \quad S_2 = \frac{wG}{e_2}$$

% change =

$$\frac{S_2 - S_1}{S_1} \times 100 = \left(\frac{S_2}{S_1} - 1\right) \times 100 = \left(\frac{e_1}{e_2} - 1\right) \times 100$$

e_1 = void ratio of borrow pit = 1.2

e_2 = void ratio of borrow compacted fill = 0.7

$$\therefore \text{ \% change} = \left(\frac{1.2}{0.7} - 1\right) \times 100 = 71.43\%$$

41. Ans: (b)

Sol:

Theoretically $\gamma_{dry\ max}$ is obtained at zero air voids when s = 1

$$\rho_{dry\,max} = \frac{G.\rho_w}{1 + WG}$$

$$1.9 = \frac{G(1)}{1 + (0.16G)} = \frac{G}{1 + 0.16G}$$

$\therefore$ G = 2.73

42. Ans: (d)

Sol:

As viscosity increases, penetration value decreases.

Viscosity grading	**Penetration value at 25°C**
VG10	80-100
VG20	60-80
VG30	50-70
VG40	40-60

43. Ans: (b)

Sol: As "U" is less than 60% $\left[\frac{0.2}{0.5} \times 100 = 40\%\right]$

$$U \propto \sqrt{t} \quad \left[\because T_v = \frac{C_v \times t}{d^2} = \frac{\pi}{4}\left[\frac{U}{100}\right]^2\right]$$

Let "S" be the settlement

Then

$S \propto \sqrt{t}$

$t = CS^2$ C = Constant

S = 0.2 m at t = 2 years

$$C = \frac{2}{(0.2)^2} = 50$$

$t = 50S^2$

Disintegration w.r.t time

$$1 = 50 \times 2S \times \frac{dS}{dt}$$

$$\frac{dS}{dt} = \frac{1}{100 \times S}$$

44. Ans: (c) **45. Ans: (b)** **46. Ans: (c)**

47. Ans: (b)

Sol:

IRC-1934

Jayakar committee-1927

Nagpur Road conference -1943

48. Ans: (c)

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49. Ans: (b)

Sol:

$$e = \frac{V^2}{225R}$$

$$= \frac{90^2}{225 \times 500}$$

$$= 5.7\%$$

50. Ans: (a)

Sol:

n is rail length for B.G i.e. 12.8 m $\simeq$ 13 m

$$\text{Total number of rails} = \frac{1000}{13} \simeq 79$$

Number of sleepers for one rail = n + 5

= 13 + 5 = 18

Total number of sleepers = 18 × 79 = 1422 sleepers

51. Ans: (b)

Sol:

Distance travelled by Car C at 10 sec

$$v = 60 \times \frac{5}{18} = 16.7 \text{ m/s}$$

= 16.7 × 10 = 167 m

Distance between A and C is 230 m

Similarly, Car A will cover a distance of 120 m in the same 10 sec

120 + 167 = 287 m > 230 m

Hence not safe

$\therefore$ Car A will colloid with car C.

52. Ans: (c)

53. Ans: (a)

Sol:

$L \geq S$

Set back distance, $m = R - R\cos\frac{\alpha}{2}$

$S = R\,\alpha$

$$\alpha = \frac{S}{R} \text{ rad}$$

$$\alpha = \frac{209.3}{200}\frac{180}{\pi}$$

= 60 degrees

$$m = 200 - 200\cos\left(\frac{60}{2}\right)$$

m = 26.8 m

54. Ans: (c)

Sol:

Extra widening = mechanical widening + Psychological widening

$$1 = 0.55 + \frac{v}{9.5\sqrt{400}}$$

$$0.45 = \frac{v}{9.5 \times 20}$$

$v = 85.5 \simeq 85$ kmph

55. Ans: (b)

Sol:

Based on 30th highest hourly volume, the favourable operating conditions during the year

$$= \left(1 - \frac{29}{365 \times 24}\right) \times 100 = 99.67\%$$

56. Ans: (c)

Sol:

Width of parking space required, b = $l \cos\theta$

$$\frac{b_{30^\circ}}{b_{45^\circ}} = \frac{\ell \cos 30}{\ell \cos 45} = \frac{\sqrt{3}}{\sqrt{2}} = 1.22$$

57. Ans: (d)

Sol:

$$\text{Maximum flow, } q = \frac{k.V}{4} = \frac{100 \times 80}{4}$$

$$= 2000 \text{ vph}$$

58. Ans: (d)

Sol:

$$\text{Theoretical capacity } C = \frac{1000V}{S}$$

$S = 0.278\ vt + l$

$= 0.278 \times 50 \times 2.5 + 6$

$= 40.75$ m

$$C = \frac{1000 \times 50}{40.75} = 1226.99 \text{ veh/hr}$$

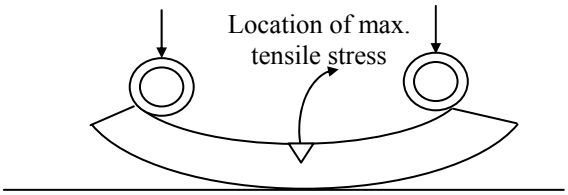
$$\simeq 1227$$

59. Ans: (a) **60. Ans: (d)** **61. Ans: (c)**

62. Ans: (a)

Sol:

During night hours, the top surface is cooler than bottom surface and ends of slab curlup resulting in loss of support for slab. Due to restraint provided by the self weight of concrete and by dowel connections, temperature tensile stresses are caused at top.



When there is negative temperature gradient during night period cause high flexural stresses in top layer which leads to top-down cracking.

63. Ans: (a) **64. Ans: (a)**

65. Ans: (a)

Sol:

Break water are used to stop wave action and sand movement in harbour area.

Break water are not required in natural harbours.

66. Ans: (c)

Sol:

Silty soils have more capillary height than sands.

67. Ans: (b)

68. Ans: (d)

Sol:

TON testing is done in cold water because increase in temperature may change the taste and odour.

69. Ans: (b)

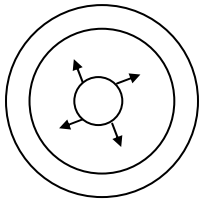
Sol:

Both the statements are correct and Statement (II) is not correct explanation correction explanation is worms are adversely affected by high concentrations of such heavy metals like cadmium, chromium, lead and zinc.

Due to this vermin-composing is not successful in municipality level.

70. Ans: (a)

Sol:



As the circumferential area increases, velocity (horizontal) velocity decreases so path of particle will be parabolic instead of straight line (in case of horizontal flow tank).

71. Ans: (d)

Sol:

Sands do not have thixotropy property.

72. Ans: (b)

Sol: The increase in deviator stress becomes progressively smaller as the air in soil voids is compressed and dissolved. The increase in the deviator stress later ceases when large stresses cause full saturation. That is why the failure envelope is not linear.

73. Ans: (a)

Sol:

In slow sand filter, a filter needs to be cleaned periodically and this is done by lowering the water level by few centimetres below the sand bed and scraping the top layer of 10-20 mm of sand. It is found in practice that draining the water through the filter bottom takes several hours at times 1-2 days. In order to obviate this difficulty, a supernatant drain out chamber with its top just above the sand level has to be provided.

74. Ans: (c)

Sol:

Soil behaviour is completely dependent on wall movement in case of active state, the mobilization of the internal resistance of soil occurs.

In passive state, the wall moves towards the fill and causes shearing resistance to build up.

75. Ans: (d)

Sol:

Masonry wall has rough surface which is against the assumption made in Rankine's theory that wall surface is smooth.