ESE-2019 PRELIMS TEST SERIES

Date: 18th November, 2018

CE (TEST-9) OBJECTIVE SOLUTION...

ANSWERS

1.	(c)	27.	(b)	53.	(b)	79.	(a)	105.	(a)	131.	(d)
2.	(c)	28.	(a)	54.	(d)	80.	(b)	106.	(b)	132.	(b)
3.	(b)	29.	(b)	55.	(a)	81.	(a)	107.	(d)	133.	(a)
4.	(b)	30.	(c)	56.	(a)	82.	(d)	108.	(c)	134.	(a)
5.	(b)	31.	(b)	57.	(b)	83.	(c)	109.	(b)	135.	(a)
6.	(d)	32.	(a)	58.	(d)	84.	(b)	110	(b)	136.	(c)
7.	(d)	33.	(a)	59.	(b)	85.	(d)	111.	(c)	137.	(a)
8.	(d)	34.	(c)	60.	(b)	86.	(c)	112.	(b)	138.	(c)
9.	(c)	35	(a)	61.	(d)	87.	(a)	113	(b)	139.	(b)
10.	(b)	36.	(d)	62.	(d)	88.	(a)	114.	(a)	140.	(d)
11.	(a)	37.	(c)	63.	(c)	89.	(c)	115.	(a)	141.	(b)
12.	(d)	38.	(b)	64.	(a)	90.	(d)	116.	(b)	142.	(d)
13.	(c)	39.	(c)	65.	(b)	91.	(b)	117.	(b)	143.	(d)
14.	(c)	40.	(d)	66.	(d)	92.	(c)	118.	(d)	144.	(b)
15.	(b)	41.	(c)	67.	(d)	93	(c)	119.	(c)	145.	(b)
16.	(a)	42.	(c)	68.	(b)	94	(d)	120.	(b)	146.	(a)
17.	(c)	43.	(b)	69.	(b)	95	(b)	121.	(a)	147.	(b)
18.	(d)	44.	(d)	70.	(b)	96	(c)	122.	(b)	148.	(b)
19.	(a)	45.	(c)	71.	(d)	97.	(c)	123.	(b)	149.	(d)
20.	(b)	46.	(d)	72.	(b)	98.	(b)	124.	(a)	150.	(a)
21.	(a)	47.	(d)	73.	(a)	99.	(d)	125.	(b)		
22.	(b)	48.	(b)	74.	(c)	100.	(d)	126.	(d)		
23.	(d)	49.	(b)	75.	(c)	101.	(a)	127.	(b)		
24.	(a)	50.	(b)	76.	(d)	102.	(c)	128.	(d)		
25.	(c)	51.	(a)	77..	(b)	103.	(b)	129.	(a)		
26.	(d)	52.	(b)	78.	(d)	104.	(b)	130.	(c)		

1. **(c)**

2. **(c)**

- Pipettle method is use for particle size of fine - grained soils
- It is a standard laboratory method.
- It is very accurate method.
- For quick particle size analysis, the hydrometer method, is more convenient.

3. **(b)**

$$DFS = \frac{\text{Volume in water} - \text{volume in kerosene}}{\text{volume in kerosene}} \times 100\%$$

$$= \frac{220-180}{180} \times 100$$

$$= 22.22\%$$

4. **(b)**

The test is halted if any one of following condition occurs.

(i) 50 blows are required for any 150 mm penetration

(ii) 100 blows are required for 300 penetration

(iii) 10 successive blows produce no advance

5. **(b)**

Preliminary exploration consist of study of local topography, excavation, cutting, drainage pattern. Detail investigation is carried out to determine the nature, sequence and thickness of various subsoil layers.

6. **(d)**

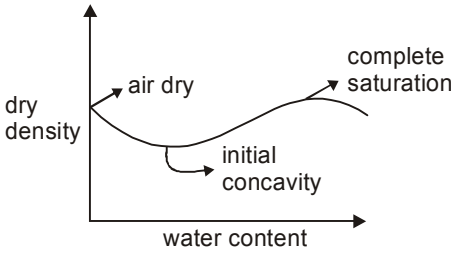
It is the field identification test of the soil.

Dilatancy (reaction to shaking) is observed in fine sand and silt. In clay, no dilatancy is observed.

7. **(d)**

- The structural water which is chemically combined to crystal structure of the soil mineral. So we can not remove on over drying at 105-110°C. It can be removed after destruction of soil structure that can be achived by increasing the temperature over 110°C.
- There are two types of adsorbed water
  (i) Hygroscopic water
  (ii) Film water

8. **(d)**



This initial concavity in curve is due to bulking of sand.

- Lambe theory is applicable for cohesive soil only.

9. **(c)**

Energy imparted in standard proctor test per unit volume = $\frac{25 \times 3 \times 2.6 \times 0.31 \times 9.81}{1000 \times 10^{-6}} = 593 \frac{J}{m^3}$

Energy imparted in modified proctor test per unit volume = $\frac{25 \times 5 \times 4.9 \times 0.45 \times 9.81}{1000 \times 10^{-6}} = 2704 \frac{J}{m^3}$

$$\therefore \text{ratio} = \frac{593}{2704} = 0.22$$

10. **(b)**

Theoretical max. dry unit weight is designated by 100% saturation or zero air void line.

So, dry unit weight = $\frac{G\gamma_w}{1+wG}$

Where G = 2.7 S = 80%

γ_w = 10 kN/m^3

w = 30 %

$$\gamma_{d_{th}} = \frac{2.7 \times 10}{1 + .30 \times 2.7} = \boxed{14.92 \text{ kN/m}^3}$$

11. **(a)**

$$\bar{\sigma} = \sigma_{total} - u$$

$$\sigma_T = \gamma_\omega \times 20 + \gamma_{sat} \times 4$$

= 10 × 20 + 20 × 4 = 280 kN/m

u = γ_w (20 + 4) = 240 kN/m^2

$$\bar{\sigma} = 280 - 240 = \boxed{40 \text{ kN/m}^2}$$

12. **(d)**

The accuray of this method depends upon the size of area unit considered. If length of the side of the area unit is less then the 1/3rd the depth at which

the stress is required, the error involved in this analysis is less than 3% only.

13. (c)

Vertical stress q_z below centre = σ × influence value × N

Influence value = $\frac{1}{n \times m} = \frac{1}{10 \times 20}$ = 0.005

$\sigma = 50\ kN/m^2$

N = 88

So, q_z = 50 × 0.005 × 88 = $\boxed{22\ kN/m^2}$

14. (c)

Using equation

$$\sigma_z = \frac{2q}{\pi z}\left[\frac{1}{1+\left(\frac{x}{z}\right)^2}\right]^2$$

Where, x = 0

z = 4 m

q = 600 kN/m

So, $\sigma_z = \frac{2 \times 600}{\pi \times 4} = 95.5\ kN/m^2$

15. (b)

We can not find top boundary flow line in the unconfined flow, Hence the flow space is not defined fully.

16. (a)

equivalent permeability of transformed section is

$\Rightarrow k_{eq} = \sqrt{k_x \,.\, k_y}$

where k_x = k

k_y = 4k

So, $\Rightarrow k_{eq} = \sqrt{1k \,.\, 4k} = \boxed{2k}$

17. (c)

Laplace's equation can be solved if the boundary condition at the inlet and exit are known.

18. (d)

The relation of permeability and other parameter are as shown below,

$$k = d^2 \frac{e^3}{1+e}\left(\frac{\gamma}{\mu}\right).k$$

d = size of sand particles

μ = viscosity of fluid

e = void ratio

γ = unit weight fluid

19. (a)

Given Length of footing, L = 3m

width of footing, B = 2m

Axial load, P = 750 KN

pressure at the base of foundation

$$q = \frac{750}{3 \times 2} = 125\ KN/m^2$$

$\therefore$ Elastic settlement $Si = \frac{q.B(1-\mu^2)}{E_s}.I_t$

$= \frac{125 \times 2 \times (1-.37^2)}{9.8 \times 10^3} \times .70m$

= $\boxed{15.5\ mm}$

20. (b)

Time factor given by, $T_v = \frac{\pi}{4}U^2$.

when U < 60%

So, $T_v = \frac{\pi}{4} \times (.5)^2 = 0.197$

So, Time factor = $\frac{C_V t_{50}}{d^2}$

where t_{50} = 41 days

d = 300 cm

[$\because$ d = Length of drainage path or $d = \frac{H_0}{2}$]

So, $0.197 = \frac{C_u \times 41}{(300)^2}$

$\boxed{C_V = 50 \times 10^{-4} cm^2/sec}$

21. (a)

total settlement given by

$$\Delta H = \frac{C_c H}{1+e_o}\log_{10}\left(\frac{\bar{\sigma}}{\bar{\sigma}_0}\right)$$

$$\frac{C_c H}{1+e_0} = \frac{2}{\log_{10}\left(\frac{200}{100}\right)} = 6.64$$

when effective stress is increased to 400 kpa.

then $\Delta H = 6.64 \log\frac{400}{100} = \boxed{4\ cm}$

22. (b)

- In initial consolidation, soil is always unsaturated.
- After completion of 1° consolidation (s = 1) effective stress remain constant then further settlement may occur due to plastic readjustment of soil solids. This reorientation is to achive more stable configuration.

23. (d)

24. (a)

Given: Strain, $\varepsilon_L = \frac{\Delta L}{L} = 10\%.\text{ or } .10$

we know, $A_f = \frac{A_o}{1-\varepsilon_L}$

$$A_f = \frac{19.63}{1-.10}$$

$$\left[\therefore A_o = \frac{\pi}{4}(5\text{cm})^2 = 19.63\ \text{cm}^2\right]$$

$$A_f = 21.82\text{cm}^2$$

We know, the axial stress at failure is known as confined compressive strength

$$q_u = \frac{P_t}{A_f} = \frac{150\text{N}}{21.82} = 6.87\ \text{N/cm}^2$$

$$C = \frac{q_u}{2} = 3.435\text{N/cm}^2 = 34.35\ \text{kN/m}^2$$

$\therefore$ Shear resistance = s = c + $\sigma\tan\phi$

For clay ϕ = 0

So, $\boxed{S = 34.35\ \text{KN/m}^2}$*

25. (c)

The dynamic shear strength is expressed as

$$S_d = (\sigma' - u_d)\tan\phi'$$

For sandy soil, the angle of internal friction ϕ' in the dynamic condition is almost equal to that in static condition.

Now the dynamic shear strength (s_d) become zero when

$$\sigma' = U_d$$

$$\frac{U_d}{\sigma'} = 1$$

$$\frac{\gamma_w h_d}{\sigma'} = 1$$

$$\left[\begin{array}{l} U_d = \gamma_w h_d \\ \text{where } h_d = \text{ dynamic hydraulic head}\end{array}\right]$$

$$\boxed{h_d = \frac{\sigma'}{\gamma_w}}$$

$\sigma' = 100\ \text{kN/m}^2$ $\gamma_w = 10\ \text{KN/m}^3$

So, $\boxed{h_d = 10\text{m}}$

26. (d)

Growth rate,

$$r = \left[t\sqrt{\frac{P_2}{P_1}} - 1\right] \times 100$$

$$= \left[2\sqrt{\frac{8,00,000}{5,00,000}} - 1\right] \times 100 = 26.49\%$$

$$\text{Population in 2010} = P_{1990}\left[1 + \frac{r}{100}\right]^2$$

$$= 8,00,000\left[1 + \frac{26.49}{100}\right]^2 = 1280000$$

27. (b)

Sonoscope test is done to check leakage in pipes.

28. (a)

- It is not used when turbidity is less than 25 ppm.
- It is based on absorption principle. Longer the light path, lower the turbidity is.

29. (b)

Pipe	rQ^2	$2rQ$
AB	1×60^2	$2\times 1\times 60$
BD	5×20^2	$2\times 5\times 20$
CD	-1×20^2	$2\times 1\times 20$
AC	-2×40^2	$2\times 2\times 40$

ΣrQ^2 = 2000

$\Sigma 2rQ$ = 520

$$\Delta Q = -\frac{\Sigma rQ^n}{\Sigma 2rQ} = -\frac{2000}{520} = -3.85$$

Discharge in the pipe where r = 5 is

20 – 3.85 = 16.15 unit

30. (c)

Detention time of skimming tank is around 3 to 5 min.

31. (b)

At peak flow efficiency decreases hence it is also checked.

32. (a)

Deers, rhinos, lions are severly effected due to noise pollution.

33. (a)

$$A = \pi r^2 = \frac{Q}{40(m^3/m^2.d)}$$

$$\Rightarrow Q = 40\pi r^2$$

weir length = $2\pi r$

$$2\pi r = \frac{Q}{360 m^3/(d.m)}$$

$$Q = 720\pi r(m^3/dm)$$

r = 18 m

34. (c)

Vermi-combusting involves stabilization of organic waste through the joint action of earth worms are aerobic micro-organism. Initially, microbial decomposition of bio-degradable organic matter occurs through extra cellular enzymatic activity (primary decomposition). Earthworms feed on partially decomposed matter consuming 5 times extra of their body weight. The ingested food is further decomposed in the guts of worms resulting in particle size reduction. The material or worm cast excreted is a fine, odourless, granular product.

35 (a)

Burning of refuse at high temperature in furnace is called incineration. It is quite a sanitary method of refuse disposal.

The various merits and demerits are given below.

Merits

1. Ensures complete destruction of pathogenic bacteria and insects
2. No odour troubles or dust nuisance
3. Some cost can be cover by selling the steam power and clinkers
4. It requires very less space for refuse disposal

Demerits and Limitations

1. It is costly method
2. Solid waste to be burnt should have high calorific value.
3. Odour and ash nuisance may result due to the improper and incompetent operation of the plant, particularly if the substances are like plastics are present in the waste

36. (d)

In aerobic digestion, a large portion of the volatile suspended solids is converted to CO_2, NH_3 and H_2, while in anaerobic digestion, a large portion of VSS is converted to CO_2, CH_4 and small quantities of H_2S and H_2.

37. (c)

Most of the coliform group of organisms reside in the alimentary tract. Members of this group have therefore been used as indicator organisms. When the pathogen is present in the sample of drinking water, the coliform group is thus also present. However, the coliform group may be present even when the pathogen is absent. It is relatively cheaper to analyze coliforms than to analyze the pathogens themselves.

38. (b)

Threshold number = Total volume of the mixture/ Volume of sample

= 200/67 = 2.98

39. (c)

1 gallon = 3.785 litre

1 ft = 0.3 m

$$t_d = \frac{v}{Q} = \frac{48\times52\times12\times(0.3)^3\,m^3}{10\times10^6\times3.785\times10^{-3}\left(\frac{m^3}{d}\right)} = 30.76 \text{ minutes}$$

40. (d)

Total hardness = $\left(\frac{Ca^{++}}{\frac{40}{2}} + \frac{Mg^{++}}{\frac{24}{2}}\right) \times$ eq. wt of $Ca(HCO_3)_2$

$$= \left(\frac{63}{\frac{40}{2}} + \frac{15}{\frac{24}{2}}\right) \times \frac{(40 + 2(1+12+48))}{2}$$

= 356.4 mg/l

41. (c)

- F/M ratio is an expression of BOD loading relating to the metabolic state of the biological system not the volume.

42. (c)

Pumping rate = $1400\times60\times24\frac{l}{day}$

Chlorine dose =3 mg/l

Chlorine required in kg/day

$= 3(mg/l) \times \left(1400 \times 60 \times 24 \frac{l}{day}\right)$

= 6.048 kg/day

43. (b)

Dilution factor = $\frac{350}{50} = 7$

Carbonaceous BOD_5

= $((D.O.)_{initial} - (D.O.)_{final}) \times$ dillution factor

= (9 – 6) × 7 = 21 mg/l

Total BoD = NBOD + CBOD

40 = NBOD + 21

NBOD = 19 mg/l

44. (d)

Chemical reaction given below

$$\underset{46}{C_2H_5OH} + \underset{96}{3O_2} \longrightarrow 2CO_2 + 3H_2O$$

Molecular weight of C_2H_5 – OH = 2 × 12 + 5 × 1 + 16 + 1

= 46 g

$\therefore$ O_2 required for 300 mg/l of CH_2 CH_5 OH

= $\frac{300 \times 3 \times 32}{46}$

= 626 mg/l

Theoretical COD = 626 mg/l

45. (c)

Anaerobic stabilised sludge is rich in nutrient than raw sludge and used for soil stabilizer.

46. (d)

RBC is a type of secondary biological process consists of series of closely spaced parallel discs mounted on a rotating shaft which is supported just above the surface of the waste water.

47. (d)

The operation of an activated-sludge treatment plant is regulated by quantity of air supplied, recirculation and excess sludge withdrawn from the system.

48. (b)

Lagoon are large shallow open pond has a detention period 1 to 2 month and may be 6 month and may be 6 months. The sludge undergoes anaerobic digestion thereby getting stabilised.

49. (b)

Septic tanks are design in such a way when sludge is applied to them, the sludge settles at bottom of tanks and oil and greases rises to the top surface as sum and sludge is digested anaerobically.

50. (b)

Composting and lagooning are mostly used for disposal of sludge.

51. (a)

Imhoff tank: It is an improvement over septic tank in which the incoming sewage is not allowed to get mixed up with the sludge produced, and the ongoing effluent is not allowed to carry with it large amount of organic load. They also known as two-storey digestion tanks.

52. (b)

Electrical conductivity depends upon concentration of total ions.

53. (b)

$T_{mix} = \frac{1200 \times 36 + 50 \times 11}{1200 + 50} = 35°C$

$\Delta T = T_{digester} - T_{mix} = 1°C$

54. (d)

The basic wind speed for any site may be obtained from Appendix IV is modified to include risk level, terrain roughness, height & size of structure, & local topography to get design wind design wind speed (V_z) at any height of structure,

$V_z = V_b \cdot k_1 \cdot k_2 \cdot k_3$

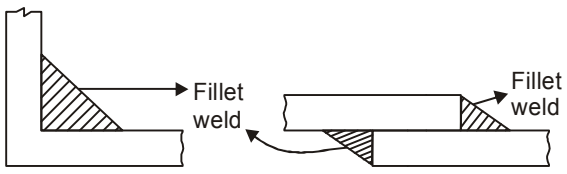
where V_z = design wind speed at any height 'z'in m/sec

k_1 = probability factor or risk coefficient

k_2 = terrain, height & structure size factor

k_3 = topography factor.

55. (a)



56. (a)

Given f_{yb} = 640 MPa

f_{ub} = 800 MPa

$$\frac{fub}{100} = \frac{800}{100} = 8$$

$\Rightarrow$ 800 × x = 640

$\Rightarrow$ $x = \frac{640}{800} = 0.8$

$\Rightarrow$ Grade of bolt = 8.8 grade HSFG

57. (b)

Pitch shall not be more than

(a) 16t or 200 mm, whichever is less, in case of tension member

(b) 12t or 200 mm, whichever is less, in case of compression members where 't' is thickness of thinner plate.

58. (d)

- The minimum effective length of the butt weld should be taken as 4 times the size of weld.
- Efficiency of welded joint is more than that of a bolted joint.

59. (b)

Bolt dia. = 20 mm

Dia. of hole = 20 + 2 = 22 mm

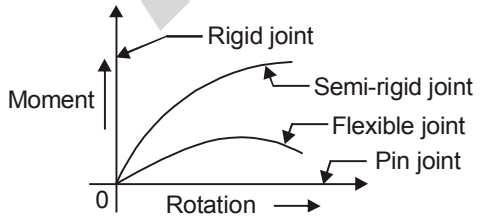
$$\text{Shear capacity} = \frac{f_u}{\sqrt{3}} \frac{\left(n_n \cdot A_{n_b} + n_s \cdot A_{s_b}\right)}{\gamma_{m_b}}$$

(where $n_n = 0$, $n_s = 2$ $A_{s_b} = \frac{\pi}{4} \times 20^2$, $\gamma_{m_b} = 1.25$)

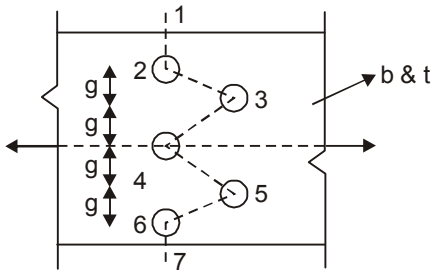
$$= \frac{800}{\sqrt{3}}\left[2 \times \frac{\pi}{4} \times 20 \times 20\right] \times \frac{1}{1.25}$$

$$= 290 \text{ kN} \times \frac{1}{1.25} = 232 \text{ kN (approx)}$$

60. (b)



61. (d)



Rupture can occur along 1– 2– 3– 4– 5– 6– 7

$$A_n = \left[b - n d_h + \sum \frac{p_i^2}{4 g_i}\right] t$$

In this case, n = 5

$$\boxed{A_n = \left[b - 5 d_h + \frac{4p^2}{4g}\right] t}$$

62. (d)

The effective length of a discontinuous strut angle if the ends are welded is given by

= 0.85 L

= 0.85 × 3000

= 2550.00 mm

= 2.55 m

63. (c)

Out of the given set of sections, the most preferred sections is circular tube as it has same radius of gyration about any cross-sectional axis.

64. (a)

The lacing system should be designed to resist a transverse shear equal to 2.5% of the column axial load i.e

$$V = \frac{2.5}{100} \times 150 = 3.75 \text{ tonnes}$$

65. (b)

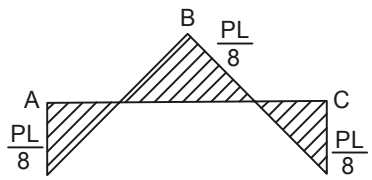
Columns in framed structures is normally subjected to combined bending & axial forces.

66. (d)

1. Shape factor represent the reserve strength of the beam section beyond yield moment to reach plastic state.
2. Load factor = shape factor × factor of safety
3. Most efficient section in bending is I-section because for a Given cross-sectional area, $\bar{y}_1$ and $\bar{y}_2$ are maximum for I-section.

67. (d)

68. (b)



All hinge at A, B and C form simultaneously

69. **(b)**

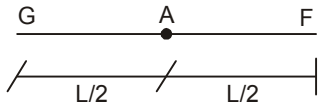
70. **(b)**

Web buckling occurs due to extensive compresive stress in the web.

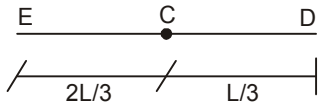
71. **(d)**

Since the given beams, AC, GF and ED are simply supported No. of hinges formed = 1

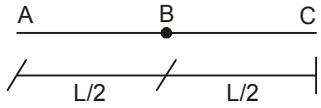
Case I : Hinge will form at A



Case II : Hinge will form at 'C'



Case III : Hinge will form at 'B'



72. **(b)**

For submerged slope of cohesionless material (without seepage)

$$F = \frac{\tan\phi}{\tan i}$$

$\phi = 30°$, $F = 1$

$$1 = \frac{\tan 30°}{\tan i}$$

$$\boxed{i = 30°}$$

73. **(a)**

74. **(c)**

As per Indian standard code IS – 2720 (part-VIII) the modified procter test have hammer weight is 4.9 kg, free fall is 450 mm and 5 layer are tamped 25 times in a mould of volume 1000 cc

$\therefore$ energy imported

$$= 4.9 \times 25 \times 5 \times 9.81 \times \frac{450}{1000}$$

$$= 2703.9 \text{ N-m}$$

For embankment compaction, the volume of soil covered by rammer = $0.1 \times 10^4 \times \frac{400}{10} = 40000\text{cc}$

energy imparted in every drop of hammer = 350 N-m

Hence No. of passes required are:

$$n \times \frac{350}{40000} = \frac{2703.9}{1000} \Rightarrow \boxed{n = 309}$$

75. **(c)**

Discharge through dam = $KH\frac{N_f}{N_d} \times L$

where $K = 3 \times 10^{-3}$ cm/s

Shape factor = $\frac{N_f}{N_d} = 4$

$L = 100$ m

$H = 52 - 4 = 48$

So,

$$Q = 3 \times 10^{-3} \times 10^{-2} \times 48 \times 4 \times 100$$

$$= 0.576 \text{ m}^3/\text{s}$$

$$= 57.6 \times 10^{-2} \text{ m}^3/\text{s}$$

76. **(d)**

It is not applicable to dense sand.

77. **(b)**

$$R_2 = \frac{1}{2}\left[1 + \frac{D_\omega}{d_f}\right]$$

$$= \frac{1}{2}\left[1 + \frac{1}{1.5}\right] = 0.83$$

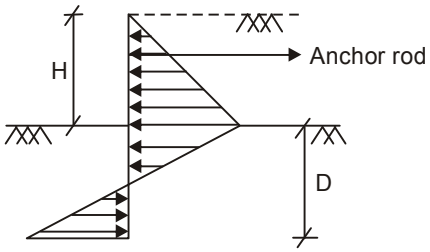
$$R_3 = \frac{1}{2}\left[1 + \frac{D'_\omega}{B}\right]$$

$$= \frac{1}{2}\left[1 + \frac{0}{2}\right] = 0.5$$

78. **(d)**

79. **(a)**

For anchored bulkhead pile in granular fill pressure diagram is represent as,



80. **(b)**

$K_a = \frac{1}{3}$ for $\phi = 30$

$K_P = 3$

maximum horizontal stress = $k_P \times$ surcharge

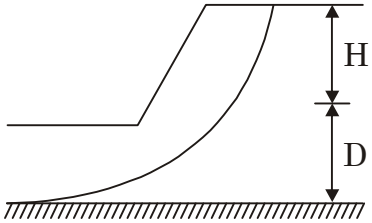
$= 3 \times 60 = 180\ kN/m^2$

Minimum horizontal stress = K_a × surcharge

$= \frac{1}{3} \times 60 = 20\ kN/m^2$

81. (a)

$D_f = \frac{H+D}{D}$



For Base failure, $D_f > 1$

For Toe failure, $D_f = 1$

82. (d)

83. (c)

$n = \frac{V_v}{V}$

$V_v = nV$

$V_V = 0.4V$

$= 0.4 \times \frac{\pi}{4}(1)^2 \times 1$

$V_v = 0.314\ m^3$

$S = \frac{V_w}{V_V}$

$\because$ S = 1 (given)

$V_V = V_w$

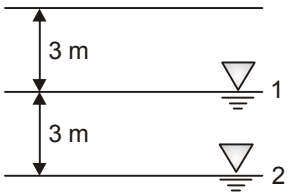
Total vol. of water = $0.314\ m^3$

Vol. of water when water level drop by 0.75 m is

$= 0.314 \times 0.75$

$= 0.235\ m^3$

84. (b)

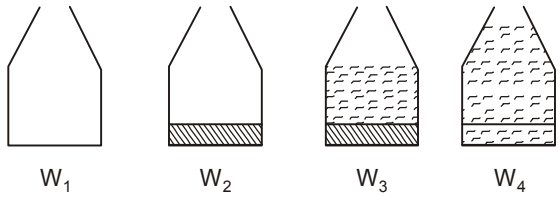


Effective stress before lowering the water at 3 m = effective stress after lower the water table at 3 m.

($\because$ As there is no change in water content upto depth of 3m after lowering of water table.)

$\therefore$ Increase in effective stress = 0

85. (d)



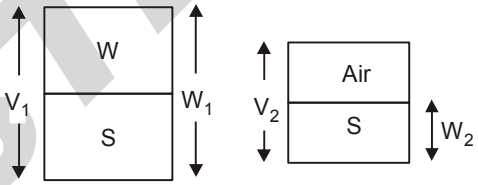
$W_2 - W_1 = 1.89N$, $W_3 = 15.81$ N, $W_4 = 14.62$ N

$G_s = \frac{\text{Wt. of solid}}{\text{Wt. of water having vol. of solid}}$

$= \frac{W_2 - W_1}{(W_4 - W_1) - (W_3 - W_2)}$

$= \frac{1.89}{14.62 - 15.81 + 1.89} = 2.7$

86. (c)



$\gamma_d = \frac{W_s}{V} = \frac{W_2}{V_2} = \frac{1.462}{77.7} N/cm^3$

$= 18.81\ kN/m^3$

87. (a)

As per Engineerig News formula

$Q = \frac{WH}{6(S+C)}$

$= \frac{50 \times 1.5 \times 10^2}{6(0.5+2.5)} = 416.67\ kN$

88. (a)

$C_u = \frac{40}{2} = 20 kN/m^2$

Skin friction capacity = $\alpha C_u(\pi dL)$

$= 1 \times 20(\pi \times 0.2 \times 8)$

$= 100.5\ kN$

89. (c)

$\sigma = 200 kN/m^2, \quad \tau = 120 kN/m^2$

$\tau = c + \sigma \tan\phi$

$120 = 200 \tan\phi$

$\phi = \tan^{-1}\left(\frac{120}{200}\right) = 31°$

90. (d)

$\sigma_d = 100 kN/m^2, \sigma_c = 150 kN/m^2$

$\sigma_1 = \sigma_d + \sigma_c - u = 250 - u \quad kN/m^2$

$\sigma_3 = \sigma_c - u = 150 - u \quad kN/m^2$

We know,

$$\sigma_1 = \sigma_3 \tan^2\left(45 + \frac{\phi}{2}\right) + 2c\tan\left(45 + \frac{\phi}{2}\right)$$

$$250 - u = (150 - u)\tan^2\left(45 + \frac{30}{2}\right) + 2 \times 10 \tan\left(45 + \frac{30}{2}\right)$$

$$250 - u = (150 - u) \times 3 + 20\sqrt{3}$$

$$250 - u = 450 - 3u + 20\sqrt{3}$$

$u = 117.3 \text{ kN/m}^2$

91. (b)

$$q = kh \times \frac{N_f}{N_d}$$

$$= 5 \times 10^{-6} \times 25 \times \frac{5}{10}$$

$= 6.25 \times 10^{-5} \text{ m}^3/\text{sec/m}$

92. (c)

$q_{nu} = CN_C$

$$N_C = 5\left[1 + \frac{0.2D_f}{B}\right]$$

$$= 5\left[1 + \frac{0.2}{B}\right]$$

$$C = \frac{120}{2} = 60 kN/m^2$$

$$\frac{P_{safe}}{b} = \frac{q_{nu}}{FOS}$$

$$\frac{120}{B} = \frac{60 \times 5}{3}\left[1 + \frac{0.2}{B}\right]$$

$$\frac{1.2}{B} = 1 + \frac{0.2}{B}$$

$$\boxed{B = 1m}$$

93 (c)

Purer the quality of water, higher is its consumption

94 (d)

95 (b)

Upflow rate, $v_f = 1 \text{ l/s/m}^2 = 10^{-3} \text{ m}^3/\text{s/m}^2$

Settling velocity = 2mm/sec = 2×10^{-3} m/sec

Effective settling velocity = $2 \times 10^{-3} - 10^{-3}$

$v_{eff} = 10^{-3}$ m/sec

Minimum depth of water required for removal of floc

$= v_{eff} \times t_d$

$= 10^{-3} \times 40 \times 60$

$= 2.4$ m

96 (c)

For the effective floc formation and removal we require flocs to be large as well as dense. Large dense flocs are easily removed in the tank, therefore smaller dense floc for large G in initial stage will combine with larger flocs with smaller G in subsequent stages.

97. (c)

Population equivalent

$$= \frac{\left(80 \times 10^6\right)\frac{l}{\text{day}} \times 250\left(\frac{\text{mg}}{l}\right)}{75\left(\frac{\text{mg}}{\text{day} - \text{person}}\right)}$$

$= 266.67 \times 10^6$

98. (b)

Depth of expanded filter bed = $\frac{(1-n)D}{(1-n_e)}$

D = 0.8 m,

$$n = \frac{e}{1+e} = \frac{1}{1+1} = 0.5, \; n_e = \frac{1.2}{1+1.2} = 0.545$$

$$\therefore \; D_e = \frac{(1-0.5) \times 0.8}{(1-0.545)} = 0.88 m$$

99. (d)

Height of chimney on the basis of SO_2 emission (in kg/hr) is given by

$h = 14 (Q_s)^{1/3}$

$= 14(27)^{1/3}$

$= 14 \times 3 = 42$ m

Height of chimney should be equal or more than 42 m. Hence option (d) is correct.

100. (d)

101. (a)

102. (c)

It is a half-full condition,

$$A = \frac{1}{2}\left(\frac{\pi}{4} \times 20^2\right) = 157 \text{ cm}^2$$

$$R = \frac{D}{4} = 5 \text{ cm}$$

Design discharge, $Q = \frac{A}{n} R^{2/3} S^{1/2}$

$= \frac{157}{0.012} \times (5)^{2/3} (0.0036)^{1/2} = 2295.3 \text{ cm}^3/\text{sec}$

= 2.29 lps

103. (b)

For the purpose of cleaning, they are placed on slope of 3 to 6 vertical to 1 horizontal.

104. (b)

$F_1 + F_2 = 200$ kN

As C.G of weld must match with the C.G. of the section

Taking moment about l_2

Hence, $200 \times 30 = F_1 \times 100$

$F_1 = 60$ kN

$\therefore F_2 = 200 - 60 = 140$ kN

105. (a)

Throat thickness, $t_t = 0.7 \times 8 = 5.6$ mm

Weld length, $l_w = (90 \times 2) + 60 = 240$ mm

Design strength $= \frac{f_u t_t l_w}{\sqrt{3}\gamma_{mw}}$

$= \frac{410 \times 5.6 \times 240}{\sqrt{3} \times 1.5} = 212.1$ kN

Safe load $= \frac{212.1}{1.5} = 141.4$ kN

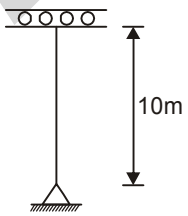
106. (b)

Transverse shear to be resisted by lacing system,

$V = \frac{2.5}{100} \times 1200 = 30$ kN

Force in lacing $= \frac{V}{2\sin\theta} = \frac{30}{2\sin 45°} = 21.2$ kN

107. (d)



Effective length = 2L = 20 m

108. (c)

Non dimensional effective slenderness ratio, $\lambda = \sqrt{\frac{f_y}{f_{cc}}}$

$f_{cc} = \frac{\pi^2 E}{(l/r)^2}$

$= \frac{\pi^2 \times 200 \times 10^3}{(8000/20)^2}$

= 12.33 MPa

$\lambda = \sqrt{\frac{250}{12.33}} = 4.5$

109. (b)

In this case, load to be transmitted by column splice = 50% of total axial load

Since the ends of the column are machined, hence load transmitted by each column splice $= \frac{850}{4} =$ 212.5 kN

110 (b)

r = 2

Number of plastic hinges = 3 which equals r + 1, hence the collapse is called complete collapse.

111. (c)

$V_z = 50$ m/sec

Design wind pressure,

$p_2 = 0.6\ V_z^2 = 0.6 \times 50^2 = 1500\ \text{N/m}^2$

112. (b)

The minimum radius of gyration is more when two unequal angles with long legs connected back to back. Thus it forms the best section for compression member.

113 (b)

As per serviceability criterion, when transverse stiffeners are not provided.

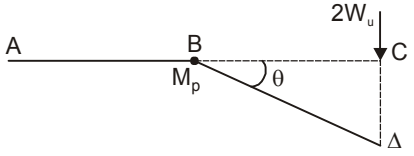
$\frac{d}{t_w} \le 200\varepsilon_w$ (web connected to flanges along both longitudinal edges)

$\frac{d}{t_w} \le 90\varepsilon_w$ (web connected to flanges along one longitudinal edge only)

114. (a)

115. (a)

1st mechanism

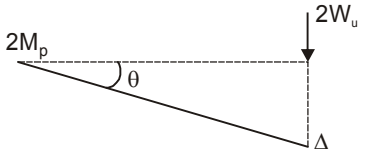


$2W_u \times \Delta = M_p\theta$

$2\ Wu \times \Delta = M_p \frac{\Delta}{L}$

$$W_u = \frac{M_p}{2L}$$

2nd mechanism



$$2Wu \times \Delta = 2M_p\theta$$

$$2W_u\Delta = 2M_p\frac{\Delta}{2L}$$

$$W_u = \frac{M_p}{2L}$$

As collapse load is $2W_u = \frac{M_P}{L}$

116. (b)

For the gantry girders located inside the building, the wind loads are not of much significance but the longitudinal and lateral loads continue to effect them. Wind loads are external and hence taken by the external frame.

117. (b)

Live loads on roof truss

If the slope of the truss is 10° or less

Live load = 0.75 kN/m^2

If slope of truss is more than 10°

Live load = 0.75 kN/m^2 – 0.02 kN/m^2 for every degree increase in slope above 10°

Live load = 0.75 – 0.02 (15 – 10)

= 0.65 kN/m^2

118. (d)

The grillage base essentially consists of steel beams encosed in concrete. They are provided when.

1. The load on the column is very heavy
2. The bearing capacity of soil on which the concrete block is to be placed may be poor

They are designed for bending, shear and web crippling,

119. (c)

A hole in the flange of a beam causes an increase in stress. If the holes are located near the region of highest flexural stress it may effect the ultimate strength of the beam. The increase in stress is of two types.

(a) Increase caused by redistribution of flexural stresses into a small area

(b) concentration of stress near the edge of the hole

120. (b)

For bracings to be effective, the connection should be near the compression flange of the beam/girder. Lateral bracings may also be effective, when bracings are resting on the top flange of the beam and connected to the beam by bolts or when open web joists are welded or bolted to the top flange.

121. (a)

122. (b)

Streeter-Phelps made the two assumptions

(1) The removal of oxygen is by micro-organism during biodegradation.

(2) The replenishment of oxygen is through reaeration at the interface between river and the atmosphere.

123. (b)

Excessive growth (blooms) of algae may cause problems such as bad taste and odour, increased color and turbidity, decreased filter run at water, treatement plant, unsightly surface scums and aesthetic problems, and even oxygen depletion after die-off.

124. (a)

Hindered settling is the settling at a reduced speed (relative to the settling velocity of a single particle) due to interactions with neighbouring particles.

Also, stokes, described the behaviour of a single spherical particle in a infinite fluid, known as free settling. However this model has limitations in practical application. Alternate considerations, such as the interaction of particles in the fluid, or the interaction particles with the container walls can modify the settling behaviour. Settling that has these forces in appreciable magnitude is known as hindered settling.

125. (b)

$$Cl_2 + H_2O \xleftrightarrow{pH>5} H^+ + Cl^- + HOCl$$

- Effective chlorine disinfection depends on its chlorine form in water.
- $Cl_2, HOCl, OCl^-$ are called as freely avialable chlorine

$$\underset{\text{(hypochlorous acid)}}{HOCl} \underset{pH<7}{\overset{pH>8}{\rightleftharpoons}} \underset{\text{(hypochlorite acid)}}{OCl^- + H^+}$$

hypochlorous acid is 80 times more effective than hypochlorite ion as disinfectant hence pH of water is maintained slightly less than 7during chlorination.

126. (d)

Sulphate reducing bacterial reduces sulphate into sulphuric acid hence it is great important in pipes made of R.C.C. which are used in sewer designs and hence in waste water apparatus design.

127. (b)

Exact calculation of size of pipes is not possible due to provision of valves on all branches in grid iron system.

128. (d)

Fresh sewage is generally alkaline in nature but as time passes, its pH tends to fall due to production of acids by bacterial action.

129. (a)

Taste and odour are the most difficult physical characteristics to measure in any numerical sense because of personal factors related to taste and odour, atmospheric conditions of impurity, temperature and humidity.

130. (c)

Excessive moisture will make it difficult to maintain aerobic conditions while deficient moisture inhibits biological life.

131. (d)

Egg-shaped sewer is used generally in combined sewer system.

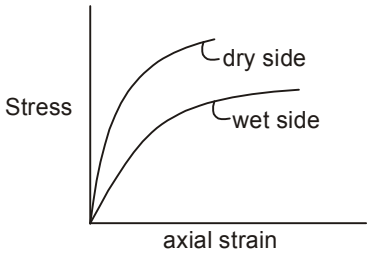
132. (b)

Algal symbiosis: Algae while growing in the presence of sunlight produces O_2 by photosynthesis and O_2 is utilized by the bacteria for oxidising the water organic matter.

133. (a)

PST remove turbidity of water so that O_2 can penetrate deep into water.

134. (a)



- The modulus of elasticity for the soil compacted on the dry side of the optimum is high such soil have brittle failure like dense sands or over consolidated clays.

135. (a)

The base of the footing being rough, when the footing sinks into the soil, a certain portion of the soil wedge immediately beneath the footing is prevented from undergoing any lateral movement by the friction and adhesion between the base of footing and the soil. This wedge of soil remains in a state of elastic equilibrium.

136. (c)

Gravity retaining walls and sheet piles walls are supported differently.

137. (a)

Reason for curved surface is wall friction considered in theory.

138. (c)

A minimum-lateral strain is needed to produce an active or a pasive state of equilibrium in a soil. When a retaining wall rotates away from the soil about its base. Only a wedge of soil between the wall and a failure plane passing through the heel of the wall at an angle of $45+\frac{\phi}{2}$ to the horizontal is thrown in a state of 'active' plastic equilibrium. At every depth within this wedge, the strain is constant and is of a magnitude sufficient to produce the active pankine state.

139. (b)

140. (d)

During the installation of sand drains, clay around drain gets remoulded, reducing the value of C_V. The phenomenon is known as smear effect.

141. (b)

142. (d)

For clay of volcanic ash and containing the mineral montmorillonite has liquid limit ranging from 400 to 600%.

143. (d)

Reason (R) is correct but assertion (A) is wrong.

In case of mild steel, the tensile strength (expressed as per unit area) of smaller diameter bars are more than that of larger diameter bars.

144. (b)

Both (A) & (R) are correct individually but (R) is not the correct explanation of (A).

145. (b)

Reinforcement is the extra weld metal which makes the throat dimension atleast 5% greater than the thickness of the welded material.

146. (a)

Both (A) and (R) are correct and (R) is correct explanation as (A).

147. (b)

148. (b)

Both statements are corrects II is not the correct explanation of I.

149. (d)

$\Rightarrow$ Splices in the column should be provided at 1/ 4^{th} height of column. In a typical column moments are high at ends and at middle section and the point of contraflexure lies somewhere in between.

150. (a)

Both (A) & (R) are correct & (R) is correct explanation of (A).