Conventional Question Practice Programe

Date: 2nd April, 2016

CE–TEST - 10 (OBJECTIVE SOLUTION)...

ANSWERS

1.	(a)	21.	(c)	41.	(b)	61.	(c)	81.	(d)	101.	(d)
2.	(c)	22.	(b)	42.	(c)	62.	(d)	82.	(d)	102.	(c)
3.	(c)	23.	(c)	43.	(d)	63.	(a)	83.	(c)	103.	(a)
4.	(a)	24.	(c)	44.	(b)	64.	(c)	84.	(d)	104.	(c)
5.	(a)	25.	(b)	45.	(b)	65.	(a)	85.	(*)	105.	(d)
6.	(a)	26.	(a)	46.	(c)	66.	(d)	86.	(a)	106.	(c)
7.	(c)	27.	(b)	47.	(d)	67.	(b)	87.	(a)	107.	(b)
8.	(a)	28.	(a)	48.	(b)	68.	(d)	88.	(d)	108.	(c)
9.	(c)	29.	(c)	49.	(c)	69.	(d)	89.	(b)	109.	(a)
10.	(d)	30.	(a)	50.	(c)	70.	(d)	90.	(c)	110.	(a)
11.	(b)	31.	(b)	51.	(a)	71.	(c)	91.	(b)	111.	(a)
12.	(a)	32.	(c)	52.	(a)	72.	(b)	92.	(c)	112:	(c)
13.	(b)	33.	(a)	53.	(a)	73.	(d)	93.	(d)	113.	(a)
14.	(d)	34.	(c)	54.	(b)	74.	(d)	94.	(c)	114.	(*)
15.	(c)	35.	(b)	55.	(b)	75.	(d)	95.	(a)	115.	(a)
16.	(b)	36.	(d)	56.	(d)	76.	(d)	96.	(c)	116.	(a)
17.	(b)	37.	(b)	57.	(a)	77.	(b)	97.	(d)	117.	(a)
18.	(c)	38.	(d)	58.	(a)	78.	(c)	98.	(d)	118.	(b)
19.	(d)	39.	(a)	59.	(d)	79.	(d)	99.	(c)	119.	(a)
20.	(a)	40.	(b)	60.	(a)	80.	(a)	100.	(b)	120.	(a)

1. **(a)**

2. **(c)**

In case of sway,

$$M_{F_{CD}} = -\frac{6E \times 2I}{3^2} = \frac{12EI}{9} = \frac{4EI}{3}$$

$$M_{F_{BA}} = -\frac{6E \times I}{2^2} = \frac{6EI}{4} = \frac{3EI}{2}$$

$$\frac{M_{F_{BA}}}{M_{F_{CD}}} = \frac{\frac{3EI}{2}}{\frac{4}{3}EI} = \frac{9}{8}$$

3. **(c)**

T = 8 years

$$\text{Risk} = 1-\left(1-\frac{1}{T}\right)^3 = 1-\left(1-\frac{1}{8}\right)^3 = 0.333$$

4. **(a)**

Peak flow Q_P is achieved at time of concentration t_C. The peak value of runoff is given by

$Q_P = CAi$; for $t \geq t_C$

If rainfall continues beyond t_C, the runoff will be constant and at the peak value Q_P.

5. **(a)**

Vertical deflection of A

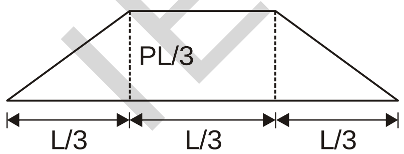
= Vertical deflection of A keeping B fixed + Angular rotation of B × l

$$= \frac{\mu l^2}{2EI} + \frac{\mu h}{EI} \times l = \frac{\mu l}{EI}\left(h + \frac{l}{2}\right)$$

6. **(a)**

7. **(c)**

8. **(a)**



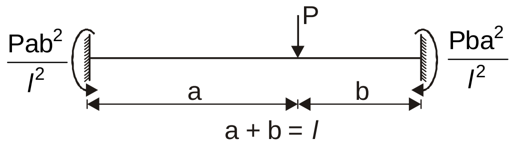
BMD

Slope at centre C is 0.

∴ Rotation at end A = Area of $\frac{M}{EI}$ diagram between A and C

$$= \frac{1}{2} \times \frac{PL}{3EI} \times \frac{L}{3} + \frac{PL}{3EI} \times \frac{L}{6} = \frac{PL^2}{9EI}$$

9. **(c)**



$$M_{AB} = -\frac{5 \times 3 \times 2^2}{5^2} = -2.4 \text{ kNm}$$

$$M_{BA} = +\frac{5 \times 2 \times 3^2}{5^2} = +3.6 \text{ kNm}$$

10. **(d)**

$C_0 + C_1 + C_2 = 1$

$\Rightarrow C_2 = 1 - 0.05 = 0.55 = 0.4$

Given : $I_1 = 20$ m³/s, $I_2 = 40$ m³/s, $Q_1 = 11$ m³/s

Hence, $Q_2 = C_0I_2 + C_1I_1 + C_2Q_1$

= 0.05 × 40 + 0.55 × 20 + 0.4 × 11

= 17.4 m³/s

11. **(b)**

$$\text{Effective Principal stress ratio} = \frac{100-10}{40-10} = 3$$

12. **(a)**

Treatment System	**Detention Time**
Grit chamber	60 sec
PST	2-2.5 hr
ASP	5-8 days
SST	1.5-2 hr
Sludge Thickner	4 hr
Sludge Digestion	30 days
Septic Tank	24 hr
Imhoff Tank	2 hr

13. **(b)**

BOD left over = 0.55 × 0.45 = 24.75%

BOD removal efficiency = 100 – 24.75

= 75.25%

14. **(d)**

$$\text{Surface loading rate} = \frac{\text{Flow rate}}{\text{Surface area}}$$

$$= \frac{1620 \text{ m}^3/\text{hr}}{15 \times 1.8 \text{ m}^2}$$

= 60m³/hr/m²

= 1000 l/min/m²

$$\text{Detention time} = \frac{\text{Volume of chamber}}{\text{Flow rate}}$$

$$= \frac{15 \times 1.8 \times 0.8\text{m}^3}{1620 \text{ m}^3/\text{hr}}$$

= 48 seconds

15. (c)

A sludge that exhibits poor settling characteristics is called a bulking sludge. Filamentous micro-organisms have been found to be responsible for a bulked sludge. Large surface area to volume ratios of these micro-organisms retard their settling velocities. Fungi are the most familiar filamentous micro-organisms. These bacteria are usually found to develop in activated sludge systems which are characteristics by the low or variable nutrient concentrations.

16. (b)

The different actions that take place in anaerobic decomposition process are

(i) **Acid fermentation stage or Acid production stage:** In this first stage of sludge digestion, the fresh sewage-sludge begins to be acted upon by anaerobic and facultative bacteria called acid formers. These organisms solubilize the organic solids through hydrolysis. The soluble products are then fermented to volatile acids and organic alcohols of low molecular weight like propionic acid, acetic acid, etc. Gases like methane, carbon dioxide and hydrogen sulphide are also evolved. Intensive acid production makes the sludge highly acidic and lowers the pH value to less than 6.

(ii) **Acid: regression stage:** In this intermediate stage, the volatile organic acids and nitrogeneous correspounds of the first stage are attacked by the bacteria so as to form acid carbonates and ammonia compounds. Small amount of hydrogen sulphide and carbon-dioxide gases are also given off. The decomposed sludge has a very offensive odour and its pH value rises a little and to be about 6.8.

(iii) **Alkaline fermentation stage:** In this final stage of sludge digestion, more resistant materials like proteins and organic acids are attacked and broken up by anaerobic bacteria called methane formers into simple substances like ammonia, organic acids and gases. During this stage, the liquid separates out from the solids and the digested sludge is formed. Digested sludge is alkaline in nature. The pH value during this stage rises to a little above 7 in the alkaline range.

17. (b)

$$M_{BA} = M_{FBA} + \frac{2EI}{L}\left(2\theta_B + \theta_A - \frac{3\delta}{l}\right)$$

$$= 0 + \frac{4EI\theta_B}{3} \qquad \{\theta_A = 0,\ \delta = 0\}$$

Similarly,

$$M_{BC} = -\frac{100\times 6^2}{12} + \frac{2E\times 4I}{6}\left(2\theta_B + \theta_C - \frac{3\delta}{l}\right)$$

$$= -300 + \frac{4EI\theta_B}{3} \qquad \{\theta_C = -\theta_B\}$$

Now, $M_{BA} + M_{BC} = 0$

$$\therefore \quad 300 = \frac{8EI\theta_B}{3}$$

$$\theta_B = \frac{900}{8EI}$$

$$M_{BA} = \frac{4EI\theta_B}{3} = \frac{4EI}{3}\times\frac{900}{8EI} = 150 \text{ kN.m}$$

18. (c)

T = 50 years

$$P = \frac{1}{50}$$

$$\text{Required probability} = {}^5C_4\cdot\left(\frac{1}{50}\right)^4\left(\frac{49}{50}\right)$$

19. (d)

20. (a)

21. (c)

$$0.18 = 1-\left(1-\frac{1}{T}\right)^2$$

$$\sqrt{0.81} = 1-\frac{1}{T}$$

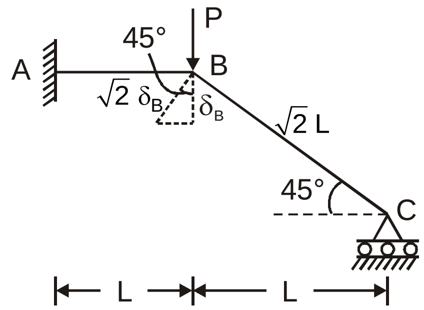
$$0.9 = 1-\frac{1}{T}$$

$$0.1 = \frac{1}{T}$$

T = 10 year

22. (b)

23. (c)



$$M_{BC} = \frac{2EI}{(\sqrt{2}\,L)}\left[2\theta_B + \theta_C - \left(-\frac{3\sqrt{2}\,\delta_B}{\sqrt{2}\,L}\right)\right]$$

$$= \frac{\sqrt{2}EI}{L}\left(2\theta_B + \theta_C + \frac{3\delta_B}{L}\right)$$

Displacement $\perp^{er}$ to BC is $\sqrt{2}\,\delta_B$ and it is in anticlockwise direction.

24. **(c)**

25. **(b)**

For rectangular channel $E_C = \frac{3}{2}y_C$

$\Rightarrow \quad 2.7 = \frac{3}{2}y_C$

$\Rightarrow \quad y_C = 1.8$ m

Acutal depth of flow = 1.6 m < 1.8 m

$\Rightarrow$ Flow is supercritical.

26. **(a)**

27. **(b)**

Pondage required = 12m³/s × 6 hr

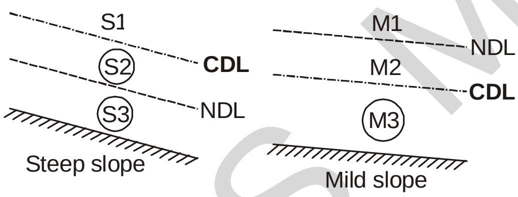
= 12 × 6 × 3600 m³

= 0.259 mm³

28. **(a)**

29. **(c)**

Supercritical flow occurs when depth of flow is below critical depth of flow.



30. **(a)**

Joint	Member	Relative Stiffness	Total Stiffness	Distribution Factor
B	BA	$\frac{4EI}{4} = EI$	2EI	1/2
	BC	$\frac{3EI}{3} = EI$		1/2

Fixed end moment

$\bar{M}_{AB} = \bar{M}_{BA} = 0$

$-\bar{M}_{BC} = \bar{M}_{CB} = \frac{6 \times 3^2}{12} = 4.5$ kNm

Moment Distribution :

A	B (1/2)	B (1/2)	C	
0	0	–4.5	4.5	FEM
	2.25	2.25		Balancing
1.125				C/o
1.125	2.25	–2.25	4.5	Total

Hence final and moment at A = 1.125 kNm

31. **(b)**

Joint	Member	Relative Stiffness	Total Relative Stiffness	Distribution factor
C	CB	$\frac{4E(2I)}{8}$		8/11
	CD	$\frac{3E(I)}{8}$	$\frac{11EI}{8}$	3/11
	CE	0		0

Since end E is free end, member CE has zero relative stiffness

32. **(c)**

33. **(b)**

$$\Delta H = \frac{H_0C_c}{1+e_0}\log\left(1+\frac{\Delta\bar{\sigma}}{\sigma_0}\right)$$

$$\frac{\Delta H_1}{\Delta H_2} = \frac{\log\left(1+\frac{80}{80}\right)}{\log\left(1+\frac{240}{80}\right)}$$

$$\frac{\Delta H_1}{\Delta H_2} = \frac{\log 2}{\log 4} = \frac{1}{2}$$

$\Delta H_1 = 2$ cm, $\Delta H_2 = 4$ cm

Further increase is 2 cm.

34. **(c)**

35. **(b)**

36. **(d)**

37. **(b)**

38. **(d)**

39. **(a)**

40. **(b)**

41. **(b)**

42. **(c)**

43. **(d)**

44. **(b)**

45. **(b)**

46. **(c)**

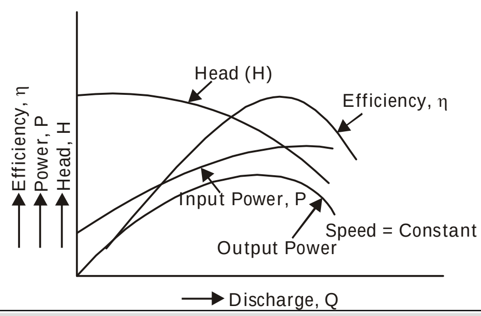
47. **(d)**

48. **(b)**

49. **(c)**

50. **(c)**

51: **(a)**



52. (a)

$$\eta_h = \frac{2(V-u)[1+\cos\phi]u}{V^2}$$

The efficiency will be maximum for a given value of V when

$$\frac{d}{du}(\eta_h) = 0$$

or $$\frac{d}{du}\left[\frac{2u(V-u)(1+\cos\phi)}{V^2}\right] = 0$$

or $$\frac{(1+\cos\phi)}{V^2}\frac{d}{du}(2uV-2u^2) = 0$$

or $$\frac{d}{du}[2uV-2u^2] = 0 \quad \left(\because \frac{1+\cos\phi}{V^2}\neq 0\right)$$

or $2V - 4u = 0$ or $u = \frac{V}{2}$

53. (a)

Pelton is impulse turbine, so has zero Degree of reaction.

54. (b)

The centrifugal pump will start delivering water if the pressure rise in the impeller is more than or equal to manometric head (H_m).

55. (b)

$$u = \phi\sqrt{2gH} = 0.44\times\sqrt{2\times 9.81\times 300}$$
$$= 33.76 \text{ m/s}$$

$$\therefore \frac{\pi DN}{60} = u$$

$$\Rightarrow D = \frac{60u}{\pi N} = \frac{60\times 33.76}{\pi\times 600} = 1.07\,\text{m}$$

56. (d)

In turbines, only reaction turbines are subjected to cavitation. In reaction turbines the cavitation may occur at the outlet of the runner or at the inlet of the draft-tube where the pressure is considerably reduced (i.e., which may be below the vapour pressure of the liquid flowing through the turbine). Due to cavitation, the metal of the runner vanes and draft-tube is gradually eaten away, which results in lowering the efficiency of the turbine. Hence, the cavitation in a reaction turbine can be noted by a sudden drop in efficiency. In order to determine whether cavitation will occur in any portion of a reaction turbine, the critical value of Thoma's cavitation factor is calculated.

57. (a)

Francis turbine is used for medium head. Kaplan is used for low heads and Pelton turbine is used for high heads.

58. (a)

For hydroelectric power uses, a surge tank is an additional storage space or reservoir fitted between the main storage reservoir and the power house. It should be as close to the power house as possible. Surge tanks are provided in high or medium head plants when there is a considerable distance beween the water source and the power unit, necessitating a long penstock. The main functions of the surge tank are

(i) when the load increases, the water moves backwards and gets stored in it

(ii) when the load decreases, additional supply of water will be provided by surge tank.

59. (d)

In centrifugal pumps the cavitation may occur at inlet of the impeller of the pump, or at the suction side of the pumps, where the pressure is considerably reduced. Hence if the pressure at the suction side of the pump drops below the vapour pressure of the liquid then the cavitation may occur. The cavitation in a pump can be noted by a sudden drop in efficiency and head. In order to determine whether cavitation will occur in any portion of the suction side of the pump, the critical value of Thoma's cavitation factor (σ) is calculated.

60. (a)

$$\left(\frac{gH}{N^2D^2}\right)_m = \left(\frac{gH}{N^2D^2}\right)_p$$

In case of multi-stage pumps, since the same liquid flows through each impeller, the discharge of a multi stage pump is same as the discharge passing through each impeller of the series.

61. (c)

Mass of water $m = 50 \times 10^{-3} \times 1000$ Kg/s = 50 Kg/s,

Head H = 40 m

so power = mgH = 50 × 9.81 × 40 = 19.6 kW.

62. (d)

A draft tube is a tube or pipe of gradually increasing area which is used for discharging water from the exit of the turbine to the tail race. This is because the pressure at the exit of the summer of a reaction turbine is generally less than atmosphereic pressure. Thus, the water at exit cannot be directly discharged to the tail race.

Also, the draft tube converts a large proportion of the kinetic energy $\left(\frac{V_2^2}{2g}\right)$ rejected at the outlet of the turbine into useful pressure energy. Without the draft tube, the kinetic energy rejected at the outlet of turbine will go waste to the tail race.

Hence by using draft tube, net head on turbine increases. The turbine develops more power and also efficiency of turbine increases.

63. (a)

64. (c)

65. (a)

66. (d)

67. (b)

The strength aspect includes fire resistance and structural integrity requirements.

68. (d)

69. (d)

The term ultimate load refers to the maximum load the member can carry before failure.

70. (d)

The design of WSM usually results in relatively large sections of structural members (compared to ULM and LSM), thereby resulting in better serviceability performance under the usual working loads.

71. (c)

The concept of modular ratio and its associated problems are avoided entirely in ULM.

72. (d)

73. (d)

It is found that the strength of concrete in biaxial compression is greater than in uniaxial compression by upto 27%.

74. (d)

$\phi = \left(\frac{\varepsilon_C \varepsilon_{st}}{d}\right)$ where ε_C is the compressive strain in the extreme concrete fibre, ε_{st} is the strain at the centroid of the tension steel and 'd' is the effective depth of the beam section.

75. (d)

Sections designed for ultimate limit states (under factored loads) must be checked for serviceability under the expected service loads.

76. (d)

The effective flange width is found to increase with span, increased web width and increased flange thickness. It also depends on the type of loading (concentrated, distributed, etc.) and the support conditions.

77. (b)

Where the flange is relatively wide, the flexual compressive stress is not uniform over its width.

78. (c)

79. (d)

The ductility requirement may be partly satisfied in the case of mild steel (Fe250), even if x_u slightly exceeds $x_{u,max}$.

80. (a)

The use of mild steel bars with relatively low allowable stress levels, is particularly effective in reducing deflections.

81. (d)

These are applicable to cases of uniformly loaded one-way continuous slabs and secondary continuous beams with atleast three spans which do not differ by more than 15% of the longest.

82. (d)

83. (c)

84. (d)

85. (*)

Only 2 is correct.

86. (a)

87. (a)

88. (d)

89. (b)

90. (c)

91. (b)

92. (c)

93. (d)

94. (c)

95. (a)

96. (c)

97. (d)

$$\because \quad C_V = \frac{K}{m_v \cdot \gamma_w}$$

$$\Rightarrow \quad K = C_V \cdot m_v \cdot \gamma_w$$

$$\therefore \quad \frac{K_A}{K_B} = \frac{(C_V)_A \cdot (m_V)_A}{(C_V)_B \cdot (m_V)_B}$$

$$= \frac{3.8 \times 10^{-4} \times 3.6 \times 10^{-4}}{1.9 \times 10^{-4} \times 1.8 \times 10^{-4}}$$

$$= 4.0$$

98. **(d)**

99. **(c)**

100. **(b)**

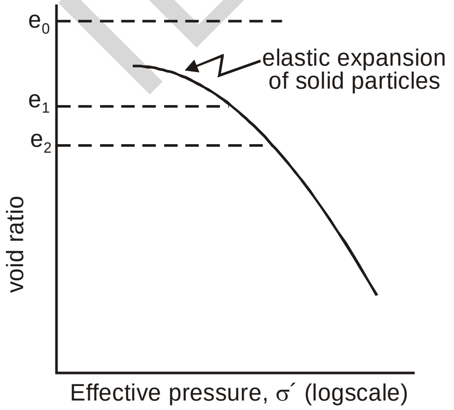
101. **(d)**

102. **(c)**

The principal advanates of dual-media and mixed-media filters over sand filters are higher filtration rates and longer filter sums because of the increased volume for floc storage within the filter.

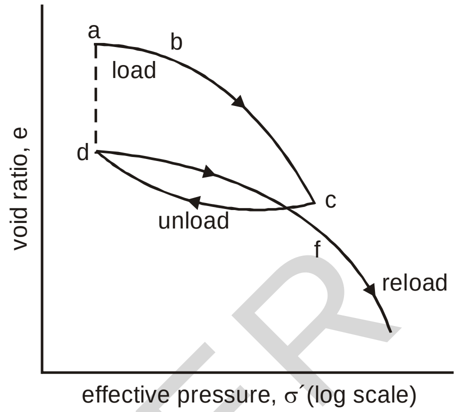
103. **(a)**

During the geological history, clays at depth might experience higher overburden pressure σ (so that also higher effective over burden pressure σ′) than the present overburden ($\sigma = \gamma z$). For example, erosion of the surface soil layers can make a clay layer become shallower and closer to the surface. When the effective pressure applied is less than the maximum effective over burden pressure in the field, a small amount of elastic pressure will occur. When the effective pressure applied is greater than the maximum effective overburden pressure in the field, the change in void ratio is much larger and make the e-log σ′ curve is practically linear and steeper.



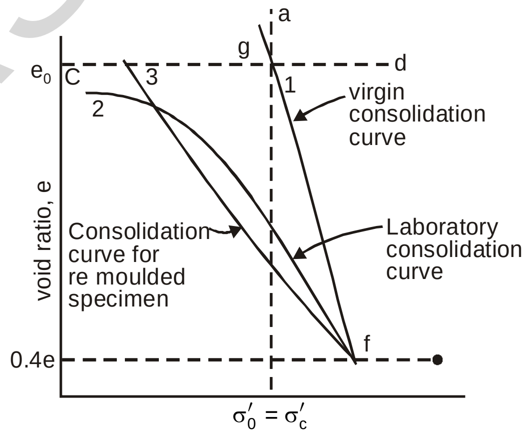
In the initial phase, relatively great change in pressure only results in less change in void ratio e. The reason is part of the pressure got to compensates the expansion of the solid particles when the soil specimen was sampled. In the following phase e changes at a great rate.

This phenomenon can be verified by the load-unload-reload process in lab consolidation experiment.

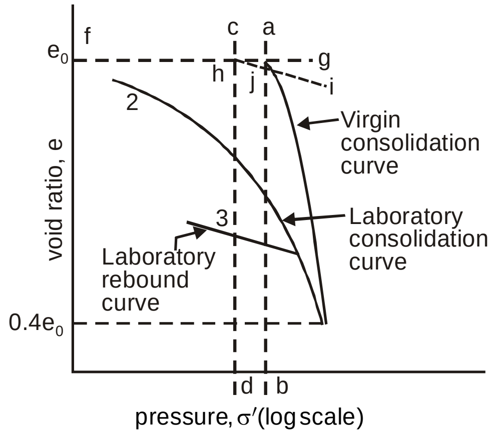


In the unload portion, segment cd contains elastic deformation and segment da is the part that can not be recovered so that is the plastic part of the deformation.

Effect of disturbance on void ratio-pressure relationship



Normall consolidated clay of low to medium plasticity



Over consolidated clay of low to medium plasticity

104. (c)

Secondary Consolidation

The reduction in volume of a soil mass caused by the application of a sustained load to the mass, due principally to the adjustment of the internal structure of the soil mass after most of the load has been transferred from the soil water to the soil solids.

Immediate Compression

The immediate compression occurs as soon as the load from the building is applied on the foundation soil and is a result of expulsion of air from voids of soil grains.

Primary Consolidation

The force applied on the soil strata also increases the pressure in the pore water. This is higher as compared to the pore water pressure in the surrounding soil, thus a hydraulic gradient is developed causing the flow of water to the surrounding areas. The time taken for the expulsion of pore water from a soil depends on the permeability of that soil.

105. (d)

Process of consolidation

There are four main stages as follows:

1. **Initially:** equilibrium (or steady state) pore water pressure, u_0 is constant (and is simply the head of water, or hydrstatic pressure = $\gamma_w z$)
2. Load applied to soil surface increases total stress on soil sample, which generated a rise in pore water pressure – Soil particles try to move closen together– but prevented by incompresible pore water. Water pressure rises Δu (excess pore water pressure), to equal the total stresses increase;

   $u = \gamma_w z$ + applied stress = $u_0 + \Delta u$
3. **Dissipation of pore water pressure:** Over a period of time (Months to years), the excess pwp, Δu, dissipates (drains slowly out of the clay due to low permeability under sustained load – i.e squeezing from voids of pressurised pore fluid). The plate like clay paricles take up new positions, resulting in settlement and increase in effective stress:

total (σ)	= effective (σ') +	p.w.p (u)
↓	↓	↓
constant	increasing	decreasing
effective (σ') =	total (σ)	– p.w.p (u)
↓	↓	↓
increasing	constant	decreasing

4. **Full dissipation of excess pwp ($\Delta u = 0$):** In the long term, excess pwp becomes zero and there is a maximum increase in effective stress, and pwp returns to its original value, u_0.

106. (c)

As per Terzaghi's theory, for the given pressure increment, the process of consolidation should be over after the dissipation of excess pore water pressure. But some compression is noticed even after the primary consolidation ceases. This is known as secondary consolidation and may be due to the highly viscous water between the points of contact of soil particles being forced out, change in arrangement of particles and possible fracture of particles because of creep. The magnitude of secondary consolidation in inorganic soils is so small compared to the primary consolidation, it is usually ignored. But in organic soils, the secondary consolidation is predominant.

The secondary consolidation is not governed by Terzaghi's consolidation theory. It is often observed that the laboratory consolidation test results are in agreement with Terzaghi's theory upto U = 60%. It means that the secondary compression takes place even before the primary consolidation is completed.

107. (b)

108. (c)

109. (a)

110. (a)

111. (a)

112: (c)

The specific speed of pelton wheel in low.

113. (a)

114. (*)

The dead load factor which is taken as 0.8 or 0.9 while considering stability against over turning or sliding or while considering reversed of stresses when dead loads are combined with wind / earthquake loads. In such cases, underestimating the counteracting effects of dead load results in greater safety.

Over estimation of strength will not result in improved safety.

115. (a)

Code specifies $\gamma_C = 1.5$ and $\gamma_s = 1.15$.

116. (a)

117. (a)

118. (b)

119. (a)

This is so, because regardless of whether the beam is under-reinforced or over-reinforced, collapse invariably occurs by the crushing of concrete.

120. (a)

Lower values of p_t and f_{st} are indicative of lower design loads and lower stains distributed across the cross-section and hence lower curvatures and lesser deflections.