GATE WALLAH

18TH FEBRUARY 2024

EVENING SESSION

ESE

ENGINEERING | SERVICE | EXAMINATION

CIVIL ENGINEERING

PAPER-2

Detailed Solution

by Team

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PAPER-II
CIVIL ENGINEERING

TIME : 2 Hours | **Maximum Marks : 300**

1. What is the temperature of the tensile strength of the stone in water for 3 days?

(a) 40°C to 50°C (b) 10°C to 15°C
(c) 20°C to 30°C (d) 5°C to 15°C

2. The decomposition of felspar is represented as

(a) $K_2AlO_3.6H_2O + CO_2 + nH_2O =$
(Orthoclase)
$K2CO_3$ +
(Alkaline carbonate)
$AlO_3.2SiO_2.2H_2O$+
(Kaolinite)
$4SiO_2.nH_2O$
(Hydrated silicate)

(b) $K_2AlO_3.6H_2O + CO_2 + nH_2O =$
(Orthoclase)
K_2CO_3 +
(Alkaline carbonate)
$AlO_3.2SiO_2.2H_2O$+
(Kaolinite)
$4SiO_2.nH_2O$
(Hydrated silicate)

(c) $K_2AlO_3.6H_2O + CO_2 + nH_2O =$
(Orthoclase)
K_2CO +
(Alkaline carbonate)
$Al_2O_3.2SiO_2.2H_2O$+
(Kaolinite)
$4SiO_2.nH_2O$
(Hydrated silicate)

(d) $K_2AlO_3.6H_2O + CO_2 + nH_2O =$
(Orthoclase)
K_2CO_3 +
(Alkaline carbonate)
$Al_2O_3.2SiO_2.2H_2O$+
(Kaolinite)
$4SiO_2.nH_2O$
(Hydrated silicate)

3. Match the following lists:

List I	List II
P. Trap and Basalt	1. Damp proofing and partitions
Q. Sandstone	2. Rough stone for masonry work
R. Laterite	3. The stone for roofing
R. Slate	4. Road metal and concrete aggregate

Select the correct answer using the code given below:

	P	Q	R	S
(a)	1	3	2	4
(b)	4	2	3	1
(c)	3	4	2	1
(d)	4	3	2	1

4. Consider the following statements regarding the characteristics of poor lime:

1. It requires less slaking time and hydrates very fast.
2. Setting and hardening is very fast.
3. The color varies from yellow to grey.

Which of the above statements is/are correct?

(a) 1 only (b) 1 and 2
(c) 3 only (d) 1 and 3

5. Consider the following statements regarding the advantages of plywood:

1. It has good strength both along as well as across the grains.
2. It will not shrink or swell across the grains.
3. It can be curved into desired shapes.

Which of the above statements is/are correct?

(a) 1 and 3 (b) 1 and 2
(c) 2 and 3 (d) 2 only

6. Match the following lists:

List I	List II
P. Bridges	1. Gamhar, haritaki
Q. Scientific Instruments	2. Red cedar, satin, sissoo
R. Railway carriage	3. Guava
R. Shuttering	4. Black wood, iron

Select the correct answer using the code given below:

	P	Q	R	S
(a)	1	2	3	4
(b)	2	3	4	1
(c)	3	2	4	1
(d)	4	2	1	3

7. Consider the following statements regarding calcined clay:

1. Its chief function is to impart strength and hydraulic properties of mortar.
2. It is dense, compact and impermeable concrete.
3. It increases the temperature of hydration and sets the concrete quickly.

Which of the above statements are correct?

(a) 2 and 3 only (b) 1 and 2 only
(c) 1 and 3 only (d) 1, 2 and 3

8. What are the concrete stages production order respectively ?

(a) Batching, mixing, transporting, placing, curing, compacting, finishing
(b) Batching, transporting, mixing, placing, compacting, curing, finishing
(c) Batching, mixing, transporting, compacting, placing, curing, finishing
(d) Batching, mixing, transporting, placing, compacting, curing, finishing

9. Consider the following statements regarding the functions of admixtures:

1. It is to speed up the rate of development of strength at early ages.
2. It increases the strength of concrete.
3. It increases the heat of evolution and decreases the durability of concrete.

Which of the above statements is/are correct?

(a) 2 and 3 only (b) 1 and 3 only
(c) 1 and 2 only (d) 1, 2 and 3

10. Consider the following statements regarding the concrete mix design:

1. It is to be compressive with strength of standard test specimens
2. It is to be compiled with the durability requirements to accept the environment.
3. It is to be capable of mixed, transported, and compacted as efficiently as possible.

(a) 1 and 3 only (b) 1, 2 and 3
(c) 2 and 3 only (d) 1 and 2 only

11. Consider the following statements regarding the design requirements of concrete mix :

1. Grade of concrete : M20, M25 connotes the characteristic strength of 30 N/mm^2 to 35 N/mm^2.
2. Type of cement: The grade of OPC such as of 33, 43 or 53 grade.
3. Type of mixing and curing water : Whether fresh potable water, seawater, ground water is to be used.

Which of the above statements are correct?

(a) 1, 2 and 3 (b) 2 and 3 only
(c) 1 and 2 only (d) 1 and 3 only

12. Consider the following statements regarding the characteristic of good mortar:

1. The density and strength of mortars made of the same class of aggregate decrease as the proportion of fine aggregate is increased.
2. It requires about twice as much cement to produce a mortar of given strength when fine sand is used as it does with coarse sand.
3. Even small percentage of mica if present considerably increases the tensile strength and adversely affects the compressive strength

Which of the above statements are correct?

(a) 1 and 2 only (b) 2 and 3 only

(c) 1 and 3 only (d) 1, 2 and 3

13. How does the bulk modulus of elasticity of a fluid change with increasing pressure?

(a) It remains constant

(b) It decreases with increase in pressure

(c) It increase with increase in pressure

(d) It becomes zerob

14. Consider the following statements regarding stability of floating bodies:

1. If metacentre (M) lies above centroid (G), then the body is said to be in unstable equilibrium.
2. If metacentre (M) lies below centroid (G), then the body is said to be in unstable equilibrium.
3. If metacentre (M) coincides with centroid (G), then the body is said to be in stable equilibrium.

Which of the above statements is/are correct?

(a) 1 and 3 (b) 2 and 3

(c) 2 only (d) 1 only

15. If V_s is the velocity of the vector, r is the radius of curvature and $\frac{\partial V_n}{\partial t}$ is the local normal acceleration; what is the expression for total normal acceleration of fluid particles ?

(a) $\frac{\partial V_n}{\partial t} = V_s^2 + r\frac{\partial V_n}{\partial t}$

(b) $\frac{\partial V_n}{\partial t} = \frac{V_s^2}{r} + r\frac{\partial V_n}{\partial t}$

(c) $\frac{\partial V_n}{\partial t} = r + V_s^2 + r\frac{\partial V_n}{\partial t}$

(d) $\frac{\partial V_n}{\partial t} = \frac{r}{V_s^2} + \frac{\partial V_n}{\partial t}$

16. Consider the following statements regarding flow measurement through pipes:

1. The reduction in constriction diameter causes velocity to increase.
2. High velocities in construction cause low pressures in the system.
3. The reduction in constriction diameter enables lesser accuracy in its measurement.

Which of the above statements is/are correct:

(a) 1 and 2 (b) 2 and 3

(c) 2 only (d) 1 and 3

17. Consider the following statements regarding ultrasonic flowmeters:

1. There are no moving parts.
2. They cannot measure flow quantities in reverse flow
3. There is no direct contract with the fluid, there is no danger of corrosion or clogging.

Which of the above statements are correct?

(a) 1 and 2 only (b) 1 and 3 only

(c) 2 and 3 only (d) 1, 2 and 3

18. When the average flow is steady, which one of the following causes significant fluctuations in velocity, temperature and pressure?

(a) Streamlines in turbulent flow

(b) Molecular diffusion in turbulent flow

(c) Eddy motion in turbulent flow

(d) Orderly flow in turbulent flow

19. Consider the following statements regarding uniform flow in channel:

1. The depth of flow and wetted area are constant at every section along the channel reach.
2. The velocity of flow and discharge are varying along the channel reach.
3. The total energy line, water surface and the channel bottom are all parallel.

Which of the above statements is/are correct?

(a) 1 and 2 (b) 2 and 3

(c) 3 only (d) 1 and 3

20. If Q = discharge into the channel, a = cross sectional area at the entrance, and D_n is depth at the channel entrance, what is the equation for depth of the reservoir (D_r) when the flow in the channel is subcritical?

(a) $D_r = D_n - \frac{Q}{2ga^2}$

(b) $D_r = D_n - \frac{Q^2}{2ga^2}$

(c) $D_r = D_n + \frac{Q}{2ga^2}$

(d) $D_r = D_n + \frac{Q^2}{2ga^2}$

21. Which one of the following heads is defined as "the head against which a centrifugal pump has to work" ?

(a) Suction head
(b) Delivery head
(c) Static head
(d) Manometric head

22. Consider the following statements regarding positive-displacement pumps:

1. Positive-displacement pump is better able to handle shear sensitive liquids.
2. A well-sealed positive-displacement pump can create a significant vacuum pressure at its inlet, even when dry.
3. The rotor(s) of a positive displacement pump run at higher speeds than the rotor (impeller) of a dynamic pump at similar loads.

Which of the above statement are correct?

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

23. Consider the following statements regarding draft tube of Francis turbine:

1. It permits a suction head to be established at the runner exit.
2. It makes possible to install the turbine above the tail race, level without loss of head.
3. It converts a large proportion of velocity energy rejected from the.

Which of the above statements is/are correct ?

(a) 1 and 2 only (b) 2 and 3 only
(c) 3 only (d) 1, 2 and 3

Sol. **(?)**

24. Consider the following statements regarding Kaplan turbine:

1. The runner blades of Kaplan turbine runner are warped
2. The blade angle is being greater at the hub than at the outer tip.
3. The peripheral velocity of the blades is being directly proportional to radius.

Which of the above statements is/are correct ?

(a) 1 and 3 only (b) 2 and 3 only
(c) 3 only (d) 1, 2 and 3

25. Match the following lists:

List I (Specific speed (rpm))	List II (Type of turbine)
P. 8.5 to 30	1. Francis turbine
Q. 50 to 340	2. Kaplan turbine
R. 255 to 860	3. Pelton wheel turbine with single jet

Select the correct answer using the code given below:

	P	Q	R
(a)	2	3	1
(b)	3	1	2
(c)	2	1	3
(d)	1	2	3

26. Consider the following statements regarding the difference between true strains and engineering strains

1. True strains for equivalent amounts of deformation in tension and compression are equal including for sign.
2. True strains are additive. For a deformation consisting of several steps the overall strain is the sum of the strains in each step.

3. The volume change is related to the sum of the three normal strains. For constant volume, $\varepsilon_x + \varepsilon_y + \varepsilon_z = 0$

Which of the above statements are current?

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

27. Consider the following statements regarding the properties of materials:

1. A material in plastic state is temporarily deformed by the application of load and it has tendency to recover.
2. Ductility is the characteristic of a material to be drawn out longitudinally to a reduced section under the action of tensile force.
3. Malleability is a property of a material which permits the materials to be partially extended in all direction without rupture.

Which of the above statements is/are correct ?

(a) 1 and 2 (b) 2 only
(c) 3 only (d) 1 and 3

28. Which one of the following statements is correct regarding the Mohr's circle of a plane Tensor ?

(a) σ is positive in tension and is plotted to the right of the origin. Compression is negative to the left

(b) τ is plotted negatively if it rotates the stress block clockwise

(c) Angles θ from one axis to another around the origin are in different direction.

(d) Any orthogonal set of axes are 90° to one another on Mohr's circle.

29. Consider the following regarding the general situations in linear elasticity:

1. The stress field is a function of only the boundary conditions, geometric shape and loading which are constant.
2. The stress field is a function of material properties like volume and deviatoric stiffness as well.
3. The loads are time independent.

Which of the above statements are correct?

(a) 1, 2 and 3 (b) 1 and 3 only
(c) 1 and 2 only (d) 2 and 3 only

30. Consider the following statements .yarding two dimensional stress formulations :

1. In a plane stresses are identical for any given geometry, loading.
2. The in-plane stresses are different for plane strain or plane stress.
3. Linear viscoelastic stress fields are. different for constant load and change with time.

Which of the above statements is/are correct ?

(a) 1 only (b) 1 and 2
(c) 3 only (d) 2 and 3

31. Which one of the following is the equation for extension of whole length of a uniformly tapering rectangular bars where b_1 and b_2 are the limits of widths ($b_2 > b_1$) length L, thickness t and the bar is subjected to an axial force P and elastic module E?

(a) $\Delta = \dfrac{PL}{(b_2 - b_1)tE} \log_e \dfrac{b_2}{b_1}$

(b) $\Delta = \dfrac{PL}{(b_2 - b_1)tE} \log_{10} \dfrac{b_2}{b_1}$

(c) $\Delta = \dfrac{PL}{(b_1 - b_2)tE} \log_{10} \dfrac{b_2}{b_1}$

(d) $\Delta = \dfrac{PLt}{(b_2 - b_1)E} \log_e \dfrac{b_2}{b_1}$

32. A conical bar tapers uniformly from a diameter of 15 mm to a diameter of 40 mm in a length of 400 mm. What is the elongation of the bar under an axial tensile force of 100 kN ? (Take E = 2×10^5 N/mm^2)

(a) 0.242 mm (b) 0.121 mm
(c) 0.424 mm (d) 0.212 mm

33. A circular section tapering bar is rigidly fixed at both the ends. The diameter changes from 75 mm at one end to 150 mm at the other end, in a length of 1.2 m. What is the maximum stress in the bar if the temperature is raised by 32°C? (Take E = 2 × 105 N/mm^2 and α = 12×10^{-6} per 1°C)

(a) 123.6 N/mm^2 (b) 143.6 N/mm^2
(c) 163.6 N/mm^2 (d) 153.6 N/mm^2

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34. A thin type of steel is to be shrunk on to a rigid wheel of 900 mm diameter. What is the internal diameter of the tyre if the hoop stress is limited to 120 N/mm^2? (For the tyre take $\alpha = 12^{-6}$ per °C and E = 2 × 10^5 N/mm^2)

(a) 899.46 mm (b) 819.46 mm
(c) 900.54 mm (d) 800.54 mm

35. Consider the following statements regarding the effective stress and effective strain:

1. $\bar{\sigma}$ and $\bar{\varepsilon}$ will reduce to ax and ex in an x-direction tension test.
2. The incremental work per volume done in deforming a material plastically is $d\omega = \bar{\varepsilon}\ d\ \bar{\sigma}$.
3. It is usually assumed that the $\bar{\sigma}$ vs $\bar{\varepsilon}$ curve describes the strain hardening for loading under a constant stress ratio α, regardless of α^*.

Which of the above statements is/are correct?

(a) 2 and 3 (b) 3 only
(c) 1 and 3 (d) 2 only

36. A solid cylinder of steel is placed inside a copper tube. The aasembly is compressed between rigid plates by forces P. What is the value of increase in temperature so-that all the loa is carried by the copper tube? (Let the parameters with suffix c represent copper and suffix s represent steel)

(a) $t = \dfrac{4P}{A_s E_s (\alpha_c - \alpha_s)}$

(b) $t = \dfrac{2P}{A_c E_c (\alpha_s - \alpha_c)}$

(c) $t = \dfrac{P(\alpha_c - \alpha_s)}{A_c E_c}$

(d) $t = \dfrac{P}{A_c E_c (\alpha_c - \alpha_s)}$

37. Match the following lists:

List I (materials)	List II (Modulus of elasticity)
P. Aluminium	1. 190
Q. Cost iron	2. 190 – 210
R. Copper	3. 70 – 79
S. Steel	4. 110 – 120
T. Wrought iron	5. 83 – 170

Select the correct answer using the code given below:

	P	Q	R	S	T
(a)	2	3	4	5	1
(b)	3	4	5	1	2
(c)	4	5	1	2	3
(d)	3	5	4	2	1

38. Which one of the following precipitations results from ocean air streams passing over land and being-deflected upward by coastal mountains, thus cooling below saturation temperature and spilling moisture ?

(a) Convective precipitation
(b) Frontal precipitation
(c) Orographic precipitation
(d) Cyclonic precipitation

39. Which one of the following terms refers to the time between the end of the net rainfall and the end of the direct runoff hydrograph?

(a) Recession time
(b) Time-to-peak
(c) Lag time
(d) Concentration time

40. Match the following lists:

List I (Soil and vegetation)	List II (Infiltration rate (mm/hr))
P. Forested loam	1. 10 – 70
Q. Loam pasture	2. 0 – 4
R. Sand	3. 3 – 15
S. Bare clay	4. 100 – 200

Select the correct answer using the code given below:

	P	Q	R	S
(a)	2	3	1	4
(b)	3	1	2	4
(c)	4	1	3	2
(d)	4	1	2	3

41. Match the following lists:

List I (Type of surface)	List II (Value of coefficient of runoff (mm/hr))
P. Wooded areas	1. 0.70 – 0.95
Q. Gravel roads and walks	2. 0.15 – 0.30
R. Macadamized Roads	3. 0.01 – 0.20
S. Watertight roof surface	4. 100 – 200

Select the correct answer using the code given below:

	P	Q	R	S
(a)	2	3	1	4
(b)	3	2	4	1
(c)	3	1	2	4
(d)	4	1	2	3

42. Consider the following statements regarding ground water:

1. Ground water is exhaustible and is evenly available.
2. Natural replenishment of the ground water resource is a very fast process
3. Ground water is generally better than surface water in respect of biological characteristics.

Which of the above statements is/are correct ?

(a) 1 and 3 only (b) 2 and 3 only

(c) 3 only (d) 1, 2 and 3

43. Match the following lists:

List I (Material)	**List II (Specific yield %)**
P. Clay	1. 5 – 15
Q. Sand and gravel	2. 15 – 25
R. Sandstone	3. 0.5 – 5
S. Limestone	4. 1 – 10

Select the correct answer using the code given below:

	P	Q	R	S
(a)	2	3	1	4
(b)	3	2	4	1
(c)	3	1	2	4
(d)	4	1	2	3

44. A fully penetrating artesian well is pumped at a rate Q = 1500 m^3/day from an aquifer whose storage coefficient and transmissivity are 4×10^{-4} and 0.145 m^2/min, respectively. Considering $\omega(u)$ = 8.62, what is the drawdowns at a distance 3 m from the production well after one hour of pumping?

(a) 8.62 m (b) 14.53 m

(c) 4.93 m (d) 2.38 m

45. Water attached to soil particles through loose chemical bonds is termed as

(a) Capillary water
(b) Gravity water
(c) Hygroscopic water
(d) Hygroscopic water

46. The water remaining in the soil after the removal of gravitational water is called

(a) Capillary water
(b) Gravity water
(c) Hygroscopic water
(d) Hygroscopic water

47. The field capacity and permanent wilting point for a given 0.8 m root-zone soil are 35 and 10 per cent, respectively. At a given time, the soil moisture in the given soil is 20 per cent when a farmer irrigates the soil with 250 mm depth of water. Assuming bulk specific gravity of the soil as 1.6, what is the amount of water wasted from the consideration of irrigation ?

(a) 23.2% (b) 58%
(c) 5.8% (d) 19.2%

48. Match the following lists:

List I (Soil texture)	List II (Field capacity)
P. Sand	1. 5 – 10
Q. Loam	2. 17 – 35
R. Silty clay	3. 18 – 25
S. Clay	4. 32 – 40

Select the correct answer using the code given below:

	P	Q	R	S
(a)	4	3	2	1
(b)	1	3	2	4
(c)	3	1	2	4
(d)	4	2	1	3

49. If V is the wind velocity and F is the fetch, for F < 32 Km, what is the formula for wave height (h_w) in gravity dams?

(a) $h_w = 1.032\sqrt{VF} + 0.76 + 0.27F^{\frac{1}{4}}$
(b) $h_w = 0.032\sqrt{VF} - 0.76 - 0.27F^{\frac{1}{4}}$
(c) $h_w = 1.032\sqrt{VF} - 0.76 + 0.27F^{\frac{1}{4}}$
(d) $h_w = 0.032\sqrt{VF} + 0.76 - 0.27F^{\frac{1}{4}}$

50. If c_1 = a dimensionless pressure coefficient, α_h = horizontal acceleration factor, ρ = mass density of water g = acceleration due to gravity, h = depth of the reservoir; what is the formula for the variation of horizontal hydrodynamic earthquake pressure with depth (P_e) in gravity dams?

(a) $P_e = C_1\alpha_h\frac{g}{h}$
(b) $P_e = \frac{C_1\alpha_h}{gh}$
(c) $P_e = C_1\alpha_h gh$
(d) $P_e = C_1 g(h + \alpha_h)$

51. Consider the following statements regarding the distribution shear stress assumptions:

1. For all values of y, q is uniform across the width of the cross-section, irrespective of its shape.
2. 'F = (dM/dx)' is derived from the assumption that bending stress varies non-linearly across the section and is not zero at the centroid.
3. The material is homogenous and isotropic and the value of E is the same for tension as well as compression.

Which of the above statements is/are correct?

(a) 1 and 2 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3

52. Which one of the following statements is NOT a property of the curves ?

(a) Both the systems of the curves cross each other at 45°.
(b) Each system crosses the N.A at 45°.
(c) At any point of a curve the tangent and normal give the directions of the two principal stresses.
(d) The intensity of stress along each curve is the greatest when it is parallel to the length of the beam and diminishes along the curve to zero, where it cuts a face of beam at right angles.

53. A rod of circular section is subjected to a shearing force on perpendicular to its axis. What is the maximum shearing stress in terms of shearing force and rod diameter, if the rod is used as a beam with free ends and a central concentrated load, express the free length in terms of diameter for which the maximum shearing stress, due to shearing force is half the maximum direct stress?

(a) L = (3/2) D (b) L = (1/2) D
(c) L = (5/2) D (d) L = (2/3) D

54. A beam 3 m long, simply supported at its ends is carrying a point load W at its mid-span. If the slope at the ends of the beam does not exceed 1°, what is the deflection at the mid-span?

(a) 17.45 mm (b) 17.45 cm
(c) 19.45 mm (d) 19.45 cm

55. Consider the following statements regarding the end conditions and internal conditions of a conjugate beam :

1. A stable and statically determinate real beam will have a conjugate beam which is also stable and statically determinate.
2. An unstable real beam will have statically indeterminate conjugate beam. Hence if a conjugate beam is found to be statically in determinate, it is concluded that the real beam is unstable and further analysis is not appropriate.
3. A statically indeterminate real beam will have stable conjugate beam. Hence its conjugate load must be such that it maintains equilibrium.

Which of the above statements is/are correct?

(a) 1 and 3 (b) 2 and 3
(c) 1 and 2 (d) 1 only

56. Which one of the following is NOT an assumption of impact loading on a beam?

(a) The falling weight sticks to the beam and moves/vibrates with it
(b) No energy loss takes place
(c) The beam is linearly non elastic
(d) The deflected shape of the beam is the same under a dynamic load as under the static load

57. Which one of the following is NOT an effect of wind on a structure?

(a) The effect of wind on a structure depends upon the density and velocity of the air
(b) It depends upon the angle of incidence of the wind
(c) It depends upon the shape and stiffness of the structure
(d) It depends upon the smoothness of the structure surface

58. Match the following lists:

List I (Basic structural elements)		**List II (Applications)**	
P.	Tin rods	1.	Carry tensile and compressive loads
Q.	Beams	2.	Members that resist axial
R.	Columns	3.	Compressive force
S.	Trusses	4.	Reinforced concreter

Select the correct answer using the code given below:

	P	Q	R	S
(a)	2	3	4	1
(b)	3	4	2	1
(c)	4	1	2	3
(d)	1	2	3	4

59. Consider the following statements regarding the principle of super position:

1. The total displacement of the stress at a point in a structure subjected to several external loadings can be determined by adding together the displacements caused by each of the displacements caused by each of the external loads acting together.
2. The material must behave in a non-linear elastic manner.
3. The geometry of the structure must not undergo significant change when the loads are applied.

Which of the above statements is/are correct?

(a) 1 and 2 (b) 2 only
(c) 3 only (d) 1 and 3

60. What is the condition for stability of truss with b number of bars, r number of external support reactions with j number of joints?

(a) $b + r = 2j$ (b) $b + r > 2j$
(c) $b + r < 2j$ (d) $b + r < j$

61. Match the following lists:

List I (components)		List II (working)	
P.	Trusses	1.	Carry compressive
Q.	Cables	2.	Located at the crown and supports elevations
R.	Arches	3.	Support their loads in tension
S.	Three-hinged arches	4.	Prevent collapse

Select the correct answer using the code given below:

	P	Q	R	S
(a)	4	3	1	2
(b)	3	2	4	1
(c)	4	1	2	3
(d)	2	3	4	1

62. Which one of the following is the condition for maximum shear in a cantilever?

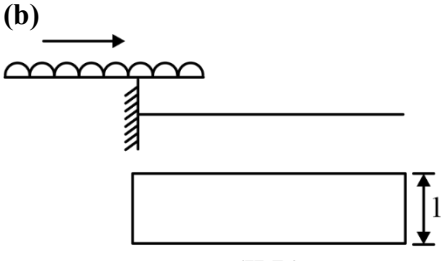
(a) It occurs when a series of concentrated loads are not placed at the farthest point away from the fixed support

(b) It occurs when a series of distributed loads are placed at the farthest point away from the fixed support

(c) It occurs when a series of concentrated loads are placed at the nearest point away from the fixed support

(d) It occurs when a series of concentrated loads are placed at the farthest point away from the fixed support

62. (b)



(ILD)

Maximum shear can be derived by ILD concept.

- Maximum shear obtained when head of u.d.l placed at free end
- Shear force = f (Area of ILD

63. Match the following lists:

List I (Type of commercial building/institution)		List II (Water demand in Litres per day)	
P.	Restaurants	1.	45 per capita
Q.	Nurses homes and medical quarters	2.	70 per seat
R.	Cinemas, concert halls and theatre	3.	135 per capita
S.	Factories	4.	15 per seat

Select the correct answer using the code given below:

	P	Q	R	S
(a)	4	1	2	3
(b)	2	1	4	3
(c)	4	3	2	1
(d)	2	3	4	1

64. Consider the following statements regarding quality difference of ground water and surface water:

1. The Turbidity of ground water is high, whereas surface water is little.
2. Total dissolved solids of ground water is lower than surface water.
3. Concentration of inorganic compounds or ions of ground water is higher than surface water.

Which of the above statements is/are correct?

(a) 1 and 2 (b) 2 only

(c) 3 only (d) 1 and 3

65. If P is population of town/city, Q is total quantity of water required during one year for a town/city; what is the formula for maximum daily per capita demand for a town/city?

(a) $1.8\times\frac{Q}{P\times 365}$ (b) $1.8\times\frac{Q}{P\times 24}$

(c) $1.5\times\frac{Q}{P\times 365}$ (d) $1.5\times\frac{Q}{P\times 24}$

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66. If P_n = Population at the end of n decade, P_o = Present population, P_{av} = Average arithmetic increase in the population (decadal), P_I = Average incremental increase in population, n = Number of decades; what is the mathematical representation of Incremental Increase Method?

(a) $P_n = P_I \times n + (P_{av} + P_o)$
(b) $P_n = P_I + (P_{av} + P_o) \times n$
(c) $P_n = P_o + (P_{av} + P_I) \times n$
(d) $P_n = P_o \times n + (P_{av} + P_I)$

67. The impurities in water which are extremely small size particles and cannot be removed by settling and filtration are known as

(a) Suspended impurities
(b) Colloidal impurities
(c) Dissolved impurities
(d) Picked up impurities

68. What is the function of flocculator in the typical water treatment scheme for surface water?

(a) To rapid dispersion of chemical coagulant(s) to encourage destabilization of colloids
(b) To permit the settlement of chemical 'flocs' along with colloidal particles
(c) To provide for gentle mixing of the destabilized colloids to promote agglomeration of colloids into large easily settleable flocs
(d) To remove the flocs and colloids which escape from the settlement in the secondary sedimentation tank

69. What is the function of rapid mixing in the typical water treatment flow scheme for ground water with high hardness?

(a) To drive out the objectionable dissolved gas such as H_2S and CO_2
(b) To permit the settlement of chemical precipitates under gravity
(c) To reform the calcium and magnesium bicarbonates to prevent settlement of $CaCO_3$ under Mg $(OH)_2$ precipitates in the distribution lines
(d) To disperse the lime and soda ash to form the chemical precipitates

70. If Q is the water requirement in L/min and P is population in thousands, what is Buston's formula to determine fire demand?

(a) $Q = 5663\sqrt{P}$
(b) $Q = 3182\sqrt{P}$
(c) $Q = 4637\left(1 - 0.01\sqrt{P}\right)$
(d) $Q = 100\sqrt{P}$

71. What is meant by soffit?

(a) The system of pipes which conveys discharges in separate pipes to the drainage system
(b) A pipe or conduit which is owned by a local authority for conveyance of the sewage
(c) The highest point of the interior of a sewer pipe at any cross section
(d) The horizontal pipe lay below the floor level or below basement to receive the discharge of soil or waste water

72. What is the logical extension of the pit privy?

(a) Septic tank and tile field
(b) Composting toilet
(c) Seepage pits
(d) Plastic pipe with holes

73. Consider the following statements regarding a good building/house drainage system :

1. The pipes should be of non- absorbent materials.
2. The system should have traps at all necessary points.
3. The branch drains should be as long as possible.

Which of the above statements are correct?

(a) 1 and 2 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3

74. What is a drawback of aerobically digested sludges?

(a) Odor reduction
(b) Enhanced putrescible
(c) Degraded of organic acids
(d) Difficulty in dewatering

75. What needs to be maintained to avoid the odour problem in tannery effluent treatment?

(a) Low pH (b) pH between 7-8

(c) pH between 9-5-10 (d) High pH

76. Which of the following is not a factor in the design of tension members?

(a) Length of the connection

(b) Type of fabrication

(c) Connection eccentricity

(d) Gross area of the cross section

77. Match the following lists:

List I (Members)		List II (Maximum effective slenderness ratio)	
P.	A tension member in which a reversal of direct stress occurs due to loads other than wind or seismic forces	1.	350
Q.	A member subjected to compressive forces resulting only from a combination of wind actions	2.	400
R.	A member normally acting as a tie in a roof truss which is not considered effective when subject to reversal of stress resulting from the earthquake	3.	180
S.	Members always in tension	4.	250

Select the correct answer using the code given below:

	P	Q	R	S
(a)	2	3	4	1
(b)	3	4	1	2
(c)	3	4	2	1
(d)	2	4	1	3

78. Which one of the following is NOT a parameter for determining the strength of the column?

(a) Material of the column

(b) Cross-sectional configuration

(c) Width of the column

(d) Residual stress

79. Consider the following modes regarding the failure of an axially loaded column:

1. Local buckling
2. Squashing
3. Joint buckling

Which of the above modes are correct?

(a) 2 and 3 only (b) 1 and 2 only

(c) 1 and 3 only (d) 1, 2 and 3

80. Match the following lists:

List I (Sections)		List II (Limiting width to thickness ratio)	
P.	Rolled section	1.	$88\varepsilon^2$
Q.	Welded section	2.	42ε
R.	Circular hollow section	3.	$15{\cdot}7\varepsilon$
S.	Hot rolled RHS	4.	$13{\cdot}6\varepsilon$

Select the correct answer using the code given below:

	P	Q	R	S
(a)	2	3	4	1
(b)	3	1	4	2
(c)	3	4	1	2
(d)	2	4	3	1

81. Match the following lists:

List I (Types of beams with)		List II (Applications)	
P.	Angles	1.	Long spans and heavy loads
Q.	Rolled I-sections	2.	Roof purlin and sheeting rail
R.	Castellated beams	3.	Most frequently used as a beam
S.	Plate girders	4.	Long spans and light loads

Select the correct answer using the code given below:

	P	Q	R	S
(a)	3	4	1	2
(b)	3	1	4	2
(c)	2	3	4	1
(d)	2	4	1	3

82. Consider the following statements regarding the lateral torsional buckling of symmetric sections:

1. The beam has no initial imperfections and its behavior is elastic.
2. It is loaded by unequal and opposite end moments in the plane of the web.
3. The beam have residual stresses and its ends are simply supported vertically and laterally.

Which of the above statements is/are correct?

(a) 2 and 3 (b) 3 only
(c) 2 and 3 (d) 1 only

83. Which of the following is NOT a functional requirement of a girder?

(a) Strength to carry bending moment
(b) Vertical stiffness to satisfy any deflection limitation
(c) Strength to carry shear i.e. adequate web area
(d) Stiffness to reduce the buckling or post-buckling strength of the web

84. Which one of the following is NOT a difference between the behaviour of the beam-columns subject to the bending moment about minor axis to major axis?

(a) In the case of slender members under small axial load, there is very little reduction of moment capacity below Mp, since lateral torsional buckling is not a problem in weak axis bending
(b) The moment of magnification is larger in the case of beam- columns bending about their weak axis
(c) As the slenderness decreases, the failure curves in the P/P_n, y-y axis plane change from convex to concave, showing decreasing dominance of minor axis bucking
(d) The failure of short/stocky members is either due to section strength being reached at the ends or at the section of larger magnified moment

85. In practical design of steel structures, on the vertical walls, external pressure coefficient on windward wall is

(a) 0·8 (b) 0·5
(c) – 0·5 (d) – 0·8

86. Consider the following statements regarding the behavior of a column under a compression load:

1. The stress-strain properties do not remain constant throughout the section.
2. Residual stresses due to cooling after rolling the steel section and those imposed by welding during construction exist in the section before loading.
3. Due to construction details, the load is perfectly concentric and the end conditions will not vary from case to case.

Which of the above statements is/are correct?

(a) 1 and 2 (b) 1 only
(c) 2 only (d) 1 and 3

87. What is the minimum load factor for dead load as per IS 800:1984?

(a) 1·3 (b) 1·7
(c) 2·3 (d) 2·7

88. What is the grain specific gravity for humus type soil?

(a) 2·37 (b) 1·37
(c) 4·37 (d) 3·37

89. When the specific gravity of solids is known, which one of the following types of methods is used to determine the water content?

(a) Pycnometer method
(b) Rapid moisture tester method
(c) Oven-drying method
(d) Sand-replacement method

90. Which one of the following soils are transported by wind?

(a) Alluvial soils (b) Lacustrine soils
(c) Aeolian soils (d) Marine soils

91. If γ_s = unit weight of the material of falling sphere in g/cm^3, γ_t = unit weight of the liquid medium in g/cm^3, μ_t = viscosity of the liquid medium in g sec/cm^2, and D = diameter of the spherical particle in cm. According to Stokes' law, what is the formula for the terminal velocity (v) of the spherical particle?

(a) $v = \frac{1}{18}\left[\frac{(\gamma_s-\gamma_t)}{\mu_t}\right]D^2$

(b) $v = \frac{1}{8}\left[\frac{(\gamma_s+\gamma_t)}{\mu_t}\right]D^2$

(c) $v = \frac{1}{12}\left[\frac{(\gamma_s-\gamma_t)}{\mu_t}\right]D^2$

(d) $v = \frac{1}{2}\left[\frac{(\gamma_s+\gamma_t)}{\mu_t}\right]D^2$

92. Consider the following statements regarding sedimentation analysis of soil particles based on Stokes' law:

1. The finer soil particles are never perfectly spherical.
2. All the soil grains may have the same specific gravity.
3. Particles constituting to fine soil fraction may carry surface electric charges.

Which of the above statements are correct?

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

93. What is meant by Thixotropy?

(a) Property of a material which is manifested by its resistance to flow
(b) The ratio of the unconfined compression strength in the natural or undisturbed state to that in the remoulded state
(c) The compressive stress at failure, giving due allowance to the reduction in area of cross-section
(d) Phenomenon of strength loss- strength gain, with no change in volume or water content

94. Consider the following statements regarding energy heads:

1. The velocity head in soils is negligible.
2. Direction of flow is determined by the difference in total head.
3. Negative pore pressure cannot exist.

Which of the above statements are correct?

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

95. What is the value of coefficient of permeability for coarse gravel?

(a) Greater than 100 mm/s
(b) Greater than 10 mm/s
(c) Greater than 1 mm/s
(d) Less than 0·1 mm/s

96. A reinforced concrete foundation, of dimensions 18 m × 36 m, exerts a uniform pressure of 180 kN/m^2 on a soil mass, with E-value 45 MN/m^2. What is the value of immediate settlement under the foundation?

(a) 1 m (b) 1·54 m
(c) 18 mm (d) 54 mm

97. Which one of the following terms is defined as "Maximum pressure which a foundation can withstand without the occurrence of shear failure of the foundation"?

(a) Gross bearing capacity
(b) Bearing capacity
(c) Ultimate bearing capacity
(d) Safe bearing capacity

98. If S_i = immediate settlement at a corner of a rectangular flexible foundation of size L × B, B = Width of the foundation, q = Uniform pressure on the foundation, E_s = Modulus of elasticity of the soil beneath the foundation, v = Poisson's ratio of the soil, and I_t = Influence value, which is dependent on L/B. What is the immediate settlement of a flexible foundation?

(a) $S_i = q \cdot B\left(\frac{1+v^2}{E_s}\right)\cdot I_t$

(b) $S_i = q \cdot B\left(\frac{1-v}{E_s}\right)\cdot I_t$

(c) $S_i = q\left(\frac{1+v^2}{BE_s}\right)\cdot I_t$

(d) $S_i = q \cdot B\left(\frac{1-v^2}{E_s}\right)\cdot I_t$

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99. Consider the following statements regarding bearing capacity values specified in building codes:

1. The codes tacitly assume that the allowable bearing capacity is dependent only on the soil type.
2. The codes assume that the bearing capacity is dependent of the size, shape and depth of foundation.
3. Building codes are usually not up-to-date.

Which of the above statements are correct?

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

100. Which one of the following comprises two or more footings connected by a beam called strap?

(a) Continuous footing
(b) Spread footing
(c) Combined footing
(d) Cantilever footing

101. A one way slab has effective spam 3.6 m and is 150 mm thick. The live load expected on it is 3 kN/m^2. What are the design shear and loads for checking serviceability respectively?

(a) 18.225 kN, 6.75 kN
(b) 16.225 kN, 5.75 kN
(c) 18.225 kN, 7.75 kN
(d) 15.225 kN, 8.75 kN

102. Consider the following statements regarding the strength of flanged sections in flexure where the moment of resisting capacity of the flanged sections depends upon the depth of neutral axis x_u:

1. If $x_u \le D_f$, compressive force is in the flange only.
2. If $\frac{3}{7}x_u > D_f$, compressive stress in the flange uniform.
3. If $x_u > D_f$ and $\frac{3}{7}x_u > D_f$, compressive stress in flange is non uniform.

Which of the above statements is/are correct?

(a) 1 and 3 (b) 2 and 3
(c) 1 and 2 (d) 1 only

103. What is the maximum deflection for cantilever subjected to udl throughout? (Where E is the modulus of elasticity of concrete, l is the moment of inertia, L is the length of the span, P is the point load)

(a) $\frac{5\omega L^3}{384EI}$ (b) $\frac{PL^3}{3EI}$
(c) $\frac{\omega L^4}{8EI}$ (d) $\frac{PL^3}{84EI}$

104. Which one of the following is the equation for width of the step in a staircase, consider R being the rise, T being tread, D/2 being the depth and b is the width ?

(a) $b=\sqrt{\frac{R^2}{T^2}}$ (b) $b=\sqrt{R^2+T^2}$
(c) $b=\sqrt{R^2.T^2}$ (d) $b=\sqrt{R^2-T^2}$

105. Which one of the following statements is correct under safety provisions of the ACI code?

(a) Design strength is greater than required strength and design moment is greater than required moment
(b) Design strength is greater than required strength and design moment is less than required moment
(c) Design strength is less than required strength and design moment is greater than required moment
(d) Design strength is less than required strength and design moment is less than required moment

106. In the conveying of most building concrete from the mixer or truck to the form is done in bottom-dump buckets, then the chief danger during conveying is that of

(a) Transferring
(b) Moisture and temperature
(c) Segregation
(d) Vibrations

107. Which one of the following is NOT a property of an admixture ?

(a) Improve workability

(b) Increase strength

(c) Improve durability

(d) Increase permeability

108. Which one of the following is the creep co-efficient at any time? (Where C_{ct} is the creep co-efficient at any time and C_{cu} is the ultimate creep co-efficient and t is the time in days after loading)

(a) $C_{ct} = \frac{t^{0.60}}{10 + t^{0.60}} C_{cu}$

(b) $C_{ct} = \frac{t^{0.50}}{10 + t^{0.50}} C_{cu}$

(c) $C_{ct} = \frac{t^{0.40}}{10 + t^{0.40}} C_{cu}$

(d) $C_{ct} = \frac{t^{0.70}}{10 + t^{0.70}} C_{cu}$

109. Consider the following statements regarding the design of T-beams :

1. To establish flange thickness, h_f based on flexural requirements of the slab, which normally spans transversely between perpendicular T beams.
2. Determine the effective flange width b_f according to ACI limits.
3. Choose web dimensions b_w and d based on either negative bending requirements at the supports, or shear requirements by setting a reasonable upper limit on the nominal unit shear stress V_u in the beam web.

Which of the above statements are correct?

(a) 1 and 2 only (b) 2 and 3 only

(c) 1 and 3 only (d) 1, 2 and 3

110. What is the minimum thickness 'h' of non prestressed one-way slabs of length 'L' for simply supported?

(a) L/24 (b) L/10

(c) L/20 (d) L/28

111. What is the maximum bending moment of elastic plates in a square slab where q is the load shared on length l?

(a) $0.625\ ql^2$ (b) $0.00625\ ql^2$

(c) $0.0625\ ql^2$ (d) $0.000625\ ql^2$

112. What is the load factor for stem in the design procedure for cantilever retaining walls with safety?

(a) 1.2 (b) 1.6

(c) 2 (d) 2.5

113. Which one of the following types of equipment is used in topographic surveys and also for recording the shapes of buildings?

(a) Electromagnetic distance measurement devices

(b) GPS

(c) Satellite camera

(d) Aerial camera

114. Match the following lists:

List I (Correction)		List II (Formula)	
P.	Absolute length (c_a)	1.	$\frac{1}{24}\left(\frac{W}{P}\right)^2 L$
Q.	Sag (c_g)	2.	$\frac{h^2}{2L}$
R.	Alignment (c_m)	3.	$\frac{c}{l}L$

Select the correct answer using the code given below:

	P	Q	R
(a)	2	1	3
(b)	3	2	1
(c)	3	1	2
(d)	2	3	1

115. If sensitivity of a bubble tube is 30" per 2 mm division what would be the error in staff reading on a vertically held staff at a distance of 200 m, when the bubble is out of centre by 2-5 divisions?

(a) 0.073 m (b) 0.73 m

(c) 0.0073 m (d) 7.3 m

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116. ten a celestial body crosses the observer's meridian, it is said to be

(a) culminate (b) Vernal equinox
(c) obliquity (d) celestial pole

117. Why the observations of field astronomy do not involve the measurement of declination and right ascension?

(a) Because the altitude and azimuth are constantly changed to the motion of the celestial body
(b) Because the stars do not occupy fixed positions on the celestial sphere
(c) Because the distance of the sun from the earth is variable
(d) Because of the obliquity of the ecliptic

118. If the equality of back sight distance and foresight cannot be maintained, under such condition, which one of the following levelling types is most important part of geodetic surveying?

(a) Spirit levelling
(b) Reciprocal levelling
(c) Trigonometric levelling
(d) Ordinary levelling

119. Consider the following statements regarding global positioning system (GPS):

1. GPS cannot be used in all weather conditions.
2. In GPS surveying inter visibility between stations or points surveyed is not necessary.
3. High cost of GPS surveying has restricted the realization of the full potential of GPS.

Which of the above statements are correct?

(a) 1 and 2 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3 only

120. Consider the following statements regarding remote sensing surveys:

1. Different types of land use are distinguishable on images...
2. Most images lack the horizontal perspective.
3. For surveys of small areas, the cost of mobilizing a remote sensing mission may be uneconomical

Which of the above statements is/are correct?

(a) 1 and 2 (b) 2 and 3
(c) 2 only (d) 3 only

121. Consider the following statements regarding aerial photogrammetry:

1. Aerial photogrammetry has the ease with which topography of inaccessible areas can be detailed.
2. In aerial photogrammetry, there is possibility of omitting of few field data.

Which of the above statements is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

122. Match the following lists:

List-I (Region)		**List-II (Wavelength)**	
P.	Reflected IR band	1.	Less than 0.03 nm
Q.	X-ray	2.	0.1-30 cm
R.	Gamma ray	3.	0.7-3.0 μm
S.	Microwave	4.	0.03-3.0 mm

Select the correct answer using the coded given below:

	P	Q	R	S
(a)	2	3	1	4
(b)	3	4	1	2
(c)	4	1	3	2
(d)	4	1	2	3

123. Accurate transfer of surface alignment down a vertical shaft using two plumb wires can be achieved by

(a) Rise and fall method
(b) Collimation method
(c) Bowditch's method
(d) Weisbach triangle method

124. If R is the radius of the circle and Δ is deflection angle, what is the formula for external distance (E) in circular curve for use in design and setting out?

(a) $E = R\left(\sec\frac{\Delta}{2} - 1\right)$

(b) $E = R\left(1 - \sec\frac{\Delta}{2}\right)$

(c) $E = R\left(\cos\frac{\Delta}{2} - 1\right)$

(d) $E = R\left(1 - \cos\frac{\Delta}{2} - 1\right)$

125. Which one of the following situations is NOT at all suitable for tunneling?

(a) If the beds are parallel to horizontal or have approximately zero degree inclination

(b) If the beds are vertically dipping and the axis of the tunnel is perpendicular to the strike

(c) If the strike of involved beds is parallel to the axis of the tunnel

(d) Welsbach triangle method

126. Which one of the following is NOT a necessity of specifications for construction?

(a) Specification of a work is required to specify the quality and quantity of different materials required for a construction work and is one of the essential contract documents

(b) Specification is necessary to specify the equipment, tools and plans to be engaged for a work and thus enables to procure them beforehand

(c) Specification is an essential contract document and is required for Arbitration

(d) Specification has no impact on changes of cost of materials and tools i.e. the tender rate

127. What is the capital value of a premises consisting of land and a well-built house, let out for ₹800/- per month inclusive of all taxes. The house is in good condition. The rent by comparison with other premises is fair and is likely to be maintained. Assume the following data:
Outgoings: 18% of the gross rent, expected rate of return 8%, future life of the building: 60 years.

(a) ₹98,400 (b) ₹141,687.50
(c) ₹110,687.50 (d) ₹88,400

128. Which one of the following is the advantage of lump sum contract?

(a) In case of unforeseen hazards during construction, the contractor is put to unlimited hardship

(b) There may not be any hazard which could not be visualized beforehand

(c) It becomes intricate to accommodate additions, alterations of design and specifications

(d) Lump sum contract works better in civil engineering construction than for mechanical and electrical installations

129. Consider the following statements regarding the right of the contractor to terminate:

1. If the work is stopped by a court order for three months or more for any reasons.
2. If the architect fails to issue the certificate of payment in the stipulated period.
3. If the owner fails to pay the contractor after the stipulated period or certification for the payment from the consultant or the arbitrator.

Which of the above statements is/are correct?

(a) 1 and 2 (b) 2 and 3
(c) 1 and 3 (d) 2 only

130. How many number of bricks are required in 10 m^3 of brick work?

(a) 3000 numbers (b) 5000 numbers
(c) 2000 numbers (d) 4000 numbers

131. Consider the following statements regarding the essential insurance record to be maintained:

1. Workmen's compensation and employer's accountability insurance in accordance with applicable laws should be maintained.
2. Comprehensive general liability insurance to cover any solitary whichever body, or the property should be maintained.
3. Comprehensive automobile liability insurance to cover any solitary whichever body or the property damage should be maintained.

Which of the above statements is/are correct?

(a) 1 only (b) 1 and 2
(c) 3 only (d) 2 and 3

132. A supplier sends steel plates in a huge quantity to a contractor. The first batch was exhaustively examined for thickness and gave a standard deviation of 1.80. The contractor feels that the knowledge of mean within a range of 0.5 to its true value for a probability of 95% would be satisfactory. What is the size of sample?

(a) 40 numbers (b) 30 numbers
(c) 60 numbers (d) 50 numbers

133. A preliminary survey indicates that 20% of the time of a gang of workers is spent ideally. What is the total number of observations required to determine the proportion of idle time within ±5% with 95% confidence limit?

(a) 216 observations
(b) 226 observations
(c) 246 observations
(d) 236 observations

134. Consider the following statements regarding the dependency of crane load capacity:

1. The size of the crawlers is not a factor due to diminutive mounting which decreases the stability of any footing.
2. The strength of the boom is also one of the major governing factors in establishing load ratings, and any extension of the boom reduces the rating. Lowering the boom also increases the clearance radius and thus reduces the rated capacity
3. The counterweight is added to the after-end of the machine Manu-facturer's specifications provided standard and maximum counter-weights and also the crane ratings. Counter weights may be increased to a specified maximum, but the operating radius must not exceed that given by the manufacturer.

Which of the above statements is/are correct?

(a) 1 and 2 (b) 1 and 3
(c) 1 only (d) 2 and 3

135. Match the following lists regarding the physical properties of cement?

List-I		List-II	
P.	Loss on ignition	1.	Causes expansion
Q.	Insoluble	2.	Due to evaporation of moisture and carbondioxide
R.	Lime and alumina content	3.	Due to inactive materials like gypsum
S.	Sulphur content	4.	Causes unsoundness

Select the correct answer using the coded given below:

	P	Q	R	S
(a)	2	3	4	1
(b)	3	4	1	2
(c)	4	1	2	3
(d)	2	4	1	3

136. What is the proportion of acid and alkalis permitted in the water used-in construction?

(a) A 100 ml sample of water should be neutralized by not more than 2 ml of 0-1 normal NaOH of 10 ml of 0-1 normal HCI
(b) A 200 ml sample of water should be neutralized by not more than 2 ml of 0-1 normal NaOH of 10 ml of 0-1 normal HCI
(c) A 300 ml sample of water should be neutralized by not more than 2 ml of 0-1 normal NaOH of 10 ml of 0-1 normal HCI
(d) A 50 ml sample of water should be neutralized by not more than 2 ml of 0-1 normal NaOH of 10 ml of 0-1 normal HCI

137. Match the following lists regarding the different types of bricks with their applications:

List-I		List-II	
P.	Sand lime bricks	1.	Tough, durable
Q.	Face bricks	2.	Edges and curves to suit the shape
R.	Paving bricks	3.	Cheaper and used only for backup
S.	Sewer bricks	4.	Where distinct brick work finish is intended

Select the correct answer using the coded given below:

	P	Q	R	S
(a)	1	2	3	4
(b)	2	3	4	1
(c)	3	4	1	2
(d)	4	1	2	3

138. What are the two main categories of embankment slopes?

(a) Flat and Steep

(b) Recoverable and Non-recoverable

(c) Desirable and Undesirable

(d) Hazardous and Non-hazardous

139. Match the following lists:

List-I (Median widths at intersections)		List-II (Key features)	
P.	Four feet or wider	1.	Provides a pedestrian refuge and room for a dual left-turn bay
Q.	Twenty eight feet or wider	2.	Provides a pedestrian refuge and room for a left-turn bay
R.	Sixteen feet or wider	3.	Provides a pedestrian refuge
S.	Twenty feet or wider	4.	Provides refuge for a crossing passenger car

Select the correct answer using the coded given below:

	P	Q	R	S
(a)	4	1	2	3
(b)	3	4	2	1
(c)	3	4	2	1
(d)	2	3	4	1

140. If V_d is design speed (mph), $t_{p\text{-}r}$ is perception-reaction time (sec), a is deceleration rate (ft/sec^2) and G is longitudinal grade of the road (%/100). What is the expression for stopping sight distance?

(a) $SSD = 1.468 V_d t_{p-r} + \dfrac{V_d^2}{30\left(\left(\dfrac{a}{32.2}\right) \pm G\right)}$

(b) $SSD = 1.468 V_d t_{p-r} + \dfrac{V_d^2}{\left(\dfrac{a}{32.2}\right) \pm G}$

(c) $SSD = 1.468 V_d t_{p-r} - \dfrac{V_d^2}{30\left(\left(\dfrac{a}{32.2}\right) \pm G\right)}$

(d) $SSD = 1.468 V_d t_{p-r} - \dfrac{V_d^2}{\left(\dfrac{a}{32.2}\right) \pm G}$

141. If V_d is design speed (mph), e_{max} is maximum rate of superelevation, f_{max} is co-efficient of side friction. What is the expression for minimum radius of curvature (R_{min}) ?

(a) $R_{min} = \dfrac{V_d^2}{(0.01 e_{min} - f_{max})}$

(b) $R_{min} = \dfrac{V_d^2}{15(e_{min} - f_{max})}$

(c) $R_{min} = \dfrac{V_d^2}{15(e_{min} - f_{max})}$

(d) $R_{min} = \dfrac{V_d^2}{15(0.01 e_{min} + f_{max})}$

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142. What is the major difficulty in. establishing human surveillance in freeway management systems?

(a) Difficulty in integrating electronic detection with human surveillance

(b) Infrastructure for providing video to the location of the human operator

(c) Human operators have superior judgment, but they may lose attention

(d) Lack of qualified human operators

143. The weighted average of the damages caused by the individual axle load group with respect to the corresponding volume of the traffic of each group is known as

(a) Lane distribution factor

(b) Load Safety factor

(c) Vehicle damage factor

(d) Heavy-vehicle adjustment factor

144. Which one of the following is a factor that is to be multiplied by the total traffic repetitions in a lane to convert it to equivalent repetitions along the maximum distressed path?

(a) Lane distribution factor

(b) Load Safety factor

(c) Vehicle damage factor

(d) Lateral distribution factor

145. Consider the following statements regarding tunnel:

1. In hills with soft rocks, a tunnel is cheaper than a cutting.
2. The maintenance cost of a tunnel is considerably higher than that of a bridge.
3. The construction of a tunnel is costly as it requires special construction.

Which of the above statements are correct?

(a) 1 and 2 only (b) 2 and 3 only

(c) 1 and 3 only (d) 1, 2 and 3

146. Match the following lists:

List-I (Size of the tunnel)		**List-II (Purpose of the tunnel)**	
P.	Circular	1.	Water and sewage mains
Q.	Elliptical	2.	Roads and Railways
R.	Horseshoe	3.	Water and sewage

Select the correct answer using the coded given below:

	P	Q	R
(a)	2	1	3
(b)	3	1	2
(c)	3	2	1
(d)	2	3	1

147. Consider the following statements regarding full face method for tunneling in hard rocks:

1. An entire section of the tunnel is tackled at one time.
2. Mucking tracks can be laid on the tunnel floor and extended as the work progresses.
3. It is suitable for unstable rocks.

Which of the above statements are correct?

(a) 1 and 2 only (b) 2 and 3 only

(c) 1 and 3 only (d) 1, 2 and 3 only

148. Match the following lists:

List-I (Type of soil)		**List-II (Method of tunneling)**	
P.	Silt	1.	One or two ports are opened and the material flows continuously into the tunnel.
Q.	Clay	2.	One or two port doors are opened. The material is excavated and deposited at the bottom of the tunnel.
R.	Sand	3.	Tunneling is of the open type. The material settles on the floor of the shield and it should be continuously removed.

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Select the correct answer using the coded given below:

	P	Q	R
(a)	2	1	3
(b)	3	1	2
(c)	3	2	1
(d)	2	3	1

149. Which one of the following methods is achieved by drilling a drift through the tunnel from portal to portal?

(a) Blow-in method (b) Exhaust method
(c) Blow-out method (d) Natural method

150. Which one of the following types of soils will usually shrink if drained or if subjected to repeated loading?

(a) Non-cohesive soils (b) Cohesive soils
(c) Peat (d) Silts

❐❐❐

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

❑❑❑

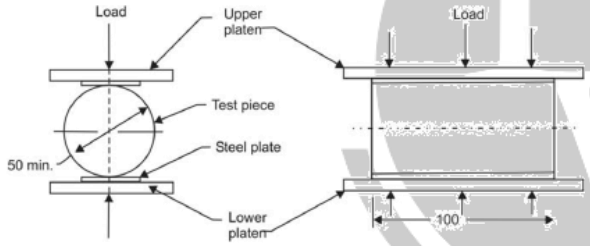
SOLUTION

1. (c)

As per IS 1121 (Part 3): 1974

Tensile Strength Test

Three cylindrical test pieces of diameter not less than 50 mm and the ratio of diameter to height 1:2 are used to determine the tensile strength of the stone in each saturated (kept in water for 3 days at 20 to 30°C) and dry condition (dried in an oven at 105 ± 5°C for 24 hours and cooled at room temperature). The general arrangement for testing tensile strength of stone is shown in Fig. 3.11. Each test piece to be tested is sandwiched in between two steel plates of width 25 mm, thickness 10 mm and length equal to the length of test piece. The load is applied without shock and increased continuously at a uniform rate until the specimen splits and no greater load is sustained. The maximum load applied to the specimen is recorded.



General Arrangement for Testing Tensile Strength of Building Stone

Note: As per Latest revison of IS 1121 (Part 3): 2012,

Vacuum saturation in water has been specified for conditioning of the test specimens in place of normal immersion,

CI: 4.3.1 The test specimens shall be saturated by vacuum saturation by immersing in water maintained at 20 °C to 30 °C in an evacuation vessel under a vacuum of about 50 mm of Hg to 100 mm of Hg.CI:

2. (b)

The disintegration of alkaline silicate of alumina in stones is mainly because of the action of chemically active water. The hydrated silicate and the carbonate forms of the alkaline materials are very soluble in water and are removed in solution leaving behind a hydrated silicate of alumina (Kaolinite). The decomposition of felspar is represented as

$K_2 AlO_3.6H_2 O + CO_2 + nH_2 O =$

[Orthoclase]

$K_2CO_3 + Al_2 . 2SiO_2 . 2HP$

[Alkaline carbonate]

$+ 4SiO_2 . nH_2O$

[Hydrated silicate]

3. (d)

Stone	Suitability
Trap and basalt (green stone white stone, blue basalt)	Suitable for road metal and conerete aggregate. Its red and yellow varieties are used for decorative features in structures.
Sand stone	It is used in the form of flag stone for paving, tile stone for roofing, nature stone for ornamental work and grit for heavy engineering works.
Laterite (sandy clay stone)	Suitable for rough stone masonry work. The modular variety yields road metal.
Slate	Most suitable for roof coverings, fluorings, damp proofing and protitions

4. (c)

Lean or poor line: It wrists of CaO + MgO 80 + 85% with MgO less than 5% and clayey impurities of about more than 7% in the form of silica, alumina and iron oxide. It sets on absorbing CO_2 from atmosphere.

Characteristics of leam or poor line.

1. Slaking requires more time and so it hydrates slowly. Its expansion is less than that of fat lime.
2. It makes thin paste with water.
3. Setting and hardening is very slow.
4. The colour varies from yellow to grey.

5. (a)

1. It has good strength both along as well as across the grains.
2. The wood shrinks or swells more across the grains. Since plywood has cross-grained construction, the tendency to shrink or swell is reduced.
3. It has better splitting resistance due to the grains in adjacent veneers in cross direction as such nailing can be done very safely even near the edges.
4. Plywood can be curved into desired shapes.

6. (b)

Table Characteristics and Uses of Timber from Various Trees

S.No	Purpose	Requirements		Nature of tree
1.	Agricultural implements	1.	Hard and durable	Bel, Arjun, Babul, Black
		2.	Should take good polish	Wood
2.	Houses	1.	Sufficiently close grained	Sissoo, Teak, Ablus, Babul
		2.	Take good polish	Haritaki, Jiyal, Kath bel,
		3.	Toughness and durability	Mahua, Nirmali, Red wood
		4.	Pleasing colour	Walnut
		5.	Easy to work with	
3.	Bridge	1.	Strength, hardness	Babul, Red cedar,
		2.	Resistance to salt water action	Nageshwar, Sal, Satin
		3.	Durability in moist places and under water	Sissoo
4.	Carts and wheels	1.	Hardness and durability	Jiyal, Arjun, Babul,
		2.	Close grained	Tamarind
5.	Columns, beams	1.	Hardness and durability	Arjun, Gamhar, Bamboo,
	door frames, etc.	2.	Should take good polish	Coconut, Palm
		3.	Flexibility	Mango, Pial, Palm
		4.	Light in weight	
		5.	Easy to work	
		6.	Lasts under water	
6.	Furniture	1.	Light, soft and durable	Teak, Champa, Deodar,
		2.	Should take good polish	Rakta-ghandan, Walnut,
		3.	Close grained	Shishum
		4.	Easy to work with	
7.	Fancy goods	1.	Easily workable	Simul, Sandal, Bamboo.
		2.	Strength and durability	Mahogany
		3.	Fairly hard and light weight	
		4.	Scented	
8.	Music	1.	Pleasing brick red colour	Toon, Walnut
	instruments	2.	Soft and easy to work	
		3.	Beautiful motteling	
9.	Scientific	1.	. Moderately hard and tough	Guava
		2.	Light	
		3.	Easy to work with	
10.	Packing boxes	1.	Soft and light in weight	Simul, Mango, Deodar
		2.	Lasts under water	
		3.	Cheap	
11.	Pegs	1.	Hardness and durability	Arjun, Coconut, Palm,
		2.	Cheap	Kher
12.		1.	Strength, hardness and durability	Red cedar, Sissoo, Sal, Nageswar, Iron wood
		2.	Close grains	
		3.	Durable in moist places and under water	
13.	Railway carriage	1.	Close grains, hardness and durability	Black wood, Teak, Iron wood, Red wood
		2.	Should take good polish	

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14.	Railway sleepers	1.	Hardness, toughness and strength	Sundari, Red cedar, Sal, Kath bel,
		2.	Durability under moist conditions	Deodar
		3.	Close grains	
15.	Scaffolding	1.	Strength and durability	Bamboo
		2.	Flexible	
		3.	Easy to work	
16.	Shuttering	1.	Hardness and durability	Nageshwar, Gamhar,
		2.	Easy to work	Haritaki
		3.	Durability in moist conditions	
17.	Ships, Boats	1.	Hardness, toughness and strength	Jarul, Babul, Teak, Nageshwar, Bakul,
		2.	Durability under salty water	
18.	Well curbs	1.	Lasts long under water	Red cedar, Palm, Banyan,
		2.	Softness and light weight	Babul, Gamhar, Mango
		3.	Easy to work	
19.	Match Box	1.	Moderately hard or soft	Kail, Simul

7. (b)

Calcined clay or surkhi is extensively used in making mortar and concrete as an adulterant for economy. But its chief function is to impart strength and hydraulic properties to mortar. When mixed with cement to react with lime liberated during the setting and hardening of cement it makes dense, compact and impermeable concrete.

8. (d)

The stages of concrete production are:

1. Batching or measurement of materials
2. Mixing
3. Transporting
4. Placing
5. Compacting
6. Curing
7. Finishing

9. (c)

The functions of admixtures are to accelerate the initial set of concrete, i.e., to speed up the rate of development of strength at early ages, retard the initial set, increase the strength of concrete, improve workability, reduce heat of evolution, increase durability of concrete—resistance to freezing and thawing, control expansion caused by aggregate-alkali reaction, decrease capillary flow of water and to make it impermeable, increase the penetration and pumpability of concrete, reduce segregation in grouts, strengthen the bond between old and new concrete surfaces and that between steel reinforcement and concrete, inhibit corrosion of concrete, increase resistance to chemical attack, produce coloured and cellular concrete, produce concrete of fungicidal, germicidal and insecticidal properties, and produce non-skid concrete surfaces.

10. (b)

The purpose of concrete mix design is to ensure the most optimum proportions of the constituent materials to meet the requirements of the structure being built. Mix design should ensure that the concrete:

(i) complies with the specifications of structural strength laid down, which is usually stated in terms of the compressive strength of standard test specimens,

(ii) complies with the durability requirements to resist the environment in which the structure will serve its functional life,

(iii) be capable of being mixed, transported, compacted as efficiently as possible without undue labour,

(iv) and lastly, but not least, be as economical as possible.

Thus, concrete mix design may be defined as the art of obtaining a concrete of the required properties, at the lowest cost, by a suitable choice and proportions of available materials.

11. (b)

Design Requirements

Before the engineer can begin to design a concrete mix the following information form the site of work is required:

(i) Grade of concrete: The grade M 20, M 25 connotes characteristic strength,/ci of 20 N/ mm2, 25 N/mm2, respectively, and standard deviation based on the degree of control to be exercised on site.

(ii) Type of cement: The grade of Ordinary Portland Cement (OPC) such as 33,43, or 53 grade. Portland Pozzolana Cement (PPC) to relevant IS specifications.

(iii) Type and size of aggregate: Natural sand, crushed stone, gravel etc. conforming to 15:383-1970, quoting the source of supply.

(iv) Nominal maximum size aggregate (MSA): 40 mm, 20 mm, 10 mm, as per 15:383-1970.

(v) Maximum/minimum cement content (kg/m^3): This is required for durability/considerations.

(vi) Type of mixing and curing water: Whether fresh potable water, seawater, ground water is to be used.

(vii) Maximum free zoater-cemcnt ratio by weight: This is required for considerations of strength and/ordurability for different exposuresand to meet appearance and other requirements. Figs 11.1 and 11.2, Tables 11.1, 11.2 and 11.3, respectively.

(viii) Degree of workability of concrete: This is dependent on placing and compaction conditions. Table 10.6.

(ix) Air content: This is inclusive of entrained air.

(x) Type of admixture used.

(xi) Maximum/ minimum density of concrete.

(xii) Maximum/minimum temperature offresh concrete.

12. (d)

Strength of hardened mortar depends on the activity of binding materials, the water-cement ratio, consumption of binding material and the quality of sand. It has been found that:

1. The density and strength of mortars made of the same class of aggregate decrease as the proportion of fine aggregate is increased.
2. It requires about twice as much cement to produce a mortar of given strength when fine sand is used as it does with coarse sand.
3. When the percentage of mixing water is increased beyond that required to form a placeable mix, the density and strength of mortar reduces. The proportionate effect is greatest at the early ages.
4. Even small percentage of mica if present considerably lowers the tensile strength and adversely affects the compressive strength.
5. There is a loss of compressive strength by the replacement of less than 25 per cent of cement by hydrated lime.
6. Cement lime mortars are helpful in autogenous healing of cracks.

13. (?)

14. (?)

15. (?)

16. (?)

17. (?)

18. (?)

19. (?)

20. (?)

21. (?)

22. (?)

23. (?)

24. (?)

25. (?)

26. (c)

- True strain for equivalent amounts of deformation in tension and compression are equal EXCEPT for sign. They will have apposite sign.
- True strains are additive
- Volumetric strain = $\varepsilon_v = \frac{\Delta V}{V}$

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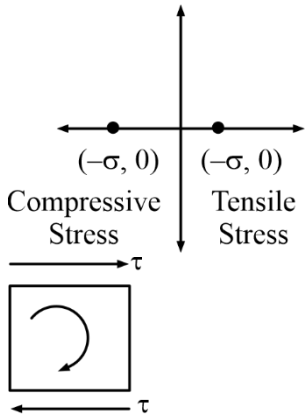
Δ_V = Change in volume.
V = original volume.
$\Delta_V = V \times \varepsilon_V$
$\varepsilon_V = \varepsilon_x + \varepsilon_y + \varepsilon_z$
$\Rightarrow \Delta_V = (\varepsilon_x + \varepsilon_y + \varepsilon_z)$
Volume change (Δ_V) is related to sum of normal strains ε_x, ε_y, ε_z.

- For constant volume i.e. $\Delta_V = 0$
$\varepsilon_V = 0$
$\Rightarrow \varepsilon_x + \varepsilon_y + \varepsilon_z = 0$

27. (b)

- Material in plastic state under go irrecoverable deformation and its permanent deformation.
- Ductility is ability of a material to be drawn out longitudinally to a reduced section under action of tensile axial force. Since section area gets reduced, material is drawn into wires.
- Malleability is property of a material which permits materials to be extended in all directions without rupture.

28. (a)



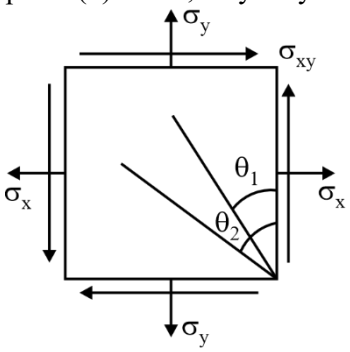
τ is plotted positive if it rotates stress block clockwise.
Orthogonal set of axes (90° to each other) are at 190° to each other on Mohr's circle.

29. (d)

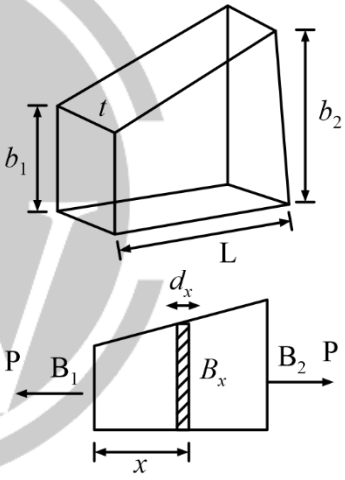
In linear elasticity stress fields are functions of materials properties like volume and deviatoric stiffness
$\sigma = \varepsilon$, E, $\tau = \phi G$, $\rho = \varepsilon vk$
Loads are considered time independent in Linear elasticity.

30. (d)

Linear viscoelastic stress fields vary with time.
The in-plane stresses depend on orientation of plane (θ) hence, they vary for different θ



31. (a)



$$B_x = B_1 + \left(\frac{B_2 - B_1}{L}\right)x$$

Area = $A_x = B_x\, t$.
Deformation of strip of length 'dx'

$$d\Delta = \frac{P dx}{(B_x t)E}$$

Total deformation L

$$\Delta = \int d\Delta = \int_0^L \frac{P\,dx}{(B_x t)E}$$

$$\Rightarrow \Delta = \frac{P}{tE}\int \frac{1}{B_1 + \frac{(B_2 - B_1)}{L}x}\,dx$$

$$\Rightarrow \Delta = \frac{P}{tE(B_2 - B_3)}\ell n\left[B_1 + \frac{(B_2 - B_1)}{L}x\right]_0^L$$

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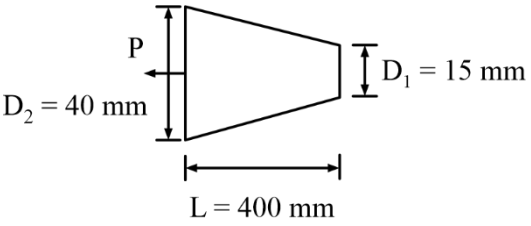
$$= \frac{PL}{(b_2 - b_1)tE} \ell nB_2 - \ell nB_1$$

$$= \frac{PL}{(B_2 - B_1)tE} \ell n\left(\frac{B_2}{B_1}\right)$$

32. (c)



$P = 100$ N

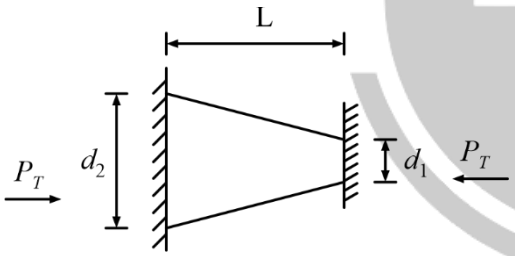
$E = 2 \times 10^5$ N/mm^2

Elongation of bar = $\Delta L = \frac{4PL}{\pi D_1 D_2 E}$

$$\Rightarrow \Delta L = \frac{4 \times 100 \times 10^3 \times 400}{\pi \times 15 \times 40 \times 2 \times 10^5}$$

= 0.424 mm.

33. (d)



Due to temperature increase free expansion $\Delta L = \alpha \Delta TL$ ---(i)

This is prevented by thermal force P_T.

Deformation due to P_T in tapered

Circular bar = $\varepsilon \frac{4P_T L}{\pi d_1 d_2 E}$ ---(ii)

Equation (i) and (ii)

$$\alpha \Delta TL = \frac{4P_T L}{\pi d_1 d_2 E}$$

$$\Rightarrow P_T = \frac{\pi \alpha \Delta T d_1 d_2 E}{4}$$

Maximum stress will occur at minimum area.

$$\sigma_{max} = \frac{P_T}{A_{min}} = \frac{\pi \alpha \Delta T d_1 d_2 E}{4 \frac{\pi}{4} d_1^2} = \alpha \Delta TE \left(\frac{d_2}{d_1}\right)$$

$$\sigma_{max} = 12 \times 10^{-6} \times 32 \times 2 \times 10^5 \times \frac{150}{75}$$

$$= 153.6 \text{ N/mm}^2$$

34. (a)

$$\text{Hoop strain} = \frac{\Delta d}{d} = \frac{\text{Hoop stress}}{E}$$

$$\Rightarrow \Delta d = \frac{\text{Hoop stress} \times d}{E}$$

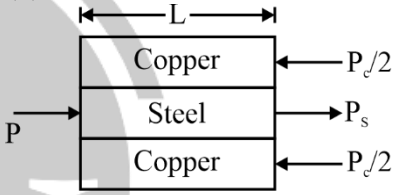
$$= \frac{120 \times 900}{2 \times 10^5} = 0.54 \text{mm}$$

Internal diameter = 900 – 0.54

= 899.46 mm.

35. (?)

36. (d)



$P = P_C + P_S$

[Given $P_S = 0$] $P = P_C$ … (i)

Also deformation of Copper and steel is same

$$\alpha_c \Delta TL - \frac{P_c L}{A_E E_C} = \alpha_S \Delta TL + \frac{P_S L}{A_S E_S}$$

From (i)

$$\Rightarrow \alpha_C \Delta TL - \frac{PL}{A_C E_C} = \alpha_S \Delta TL$$

$$\Rightarrow (\alpha_C - \alpha_S) \Delta TL = \frac{PL}{A_C E_C}$$

37. (d)

Material Aluminium allay	**Modulus of Elasticity (kN/mm^2)**
Cast iron	70-79
Copper	83-170
Steel	110-120
Wrought iron	190

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38. (c)

Orographic Precipitation

- Caused due to presence of mountain barrier
- Resulted from ocean air streams passing over land and being deflected upward by coastal mountains
- Cooling below saturation temperature
- Western Ghats

39. (a)

Recessions Time (Tr):

Time period of direct runoff, after the end of excess rainfall or net rainfall.

40. (c)

P → Forested loam = (4) 100–200

Q → Loam pasture = (1) 10–70

R → Sand = (3) 3–15

S → Base clay = (2) 0–4

41. (c)

P → Wooded area (3) 0.01 – 0.2

Q → Gravel roads (2) 0.15–0.30

R → Maeda mined road (4) 0.25–0.6

S → Water Tight roof surface (1) 0.7–0.95

42. (?)

42. (c)

Ground water generally does not contain pathogens.

Surface water gets easily contaminated.

43. (d)

P → 4

Q → 2

R → 1

S → 3

Formation	Porosity (%)	Specific Yield (%)
Clay	45–55	1–10
Sand	35–40	10–30
Gravel	30–40	15–30
Sand stone	10–20	5–15
Shale	1–10	0.5–15
Lime stone	1–10	0.5–5

44. (c)

Artesian Well

$Q = 1500\ m^3/day$

$S = 4 \times 10^{-4}$

$T = 0.145\ m^2/min = 208.8\ m^2/day$

$w(u) = 8.62$

$r = 3\ m,\ t = 1\ hour,\ S = ?$

$$S = \frac{Q}{4\pi T} w(u)$$

$$S = \frac{1500}{4 \times \pi \times 208.8} \times 8.62$$

$S = 4.93\ m$

45. (c)

Field Capacity Water

Consist 2 parts:

(a) Capillary water → Easily extracted by plants

(b) Hygroscopic water → Water adhering to soil particles by loose chemical bonds between water & soil particles. Not available for Plants

46. (d)

Field Capacity: Water retained on the surfaces of soil grains by molecular attraction & by loose chemical bonds.

47. (a)

FC = 35%, PWP = 10%, d = 0.8 m = 800 mm

OMC = 20% depth of water applied by farmer = 250

S = 1.6 % of water wasted = ?

$y = S \times d \times [FC–PWP] = 320\ mm$

$d_w = S \times d \times [FC–OMC] = 192\ mm$

$$\% \text{ wasted} = \frac{250 - 192}{250} \times 100 = 23.2\%$$

48. (b)

P – 1

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Q – 1

R – 2

S – 4

49. (d)

$h_w = 0.032\sqrt{V_F}$ for F > 32 km

$h_w = 0.032\sqrt{V_F} + 0.763 - 0.271(F)^{1/4}$

F < 32 km

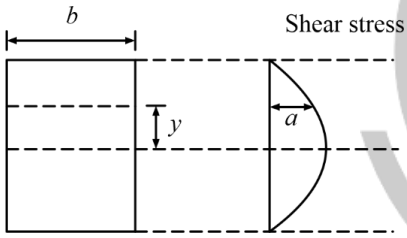
50. (c)

Hydrodynamic pressure:

$P_e = C\alpha_h wh$

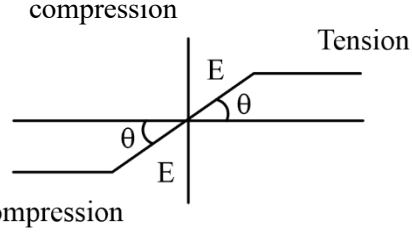
$P_e \rightarrow$ Intensity of Hydrodynamic pressure (N/m^2)
$\alpha_h \rightarrow$ Horizontal seismic co-efficient
$w \rightarrow$ Specific weight of water
$h \rightarrow$ Total depth of reservoir
$C \rightarrow$ Dimensionless co-efficient

51. (c)



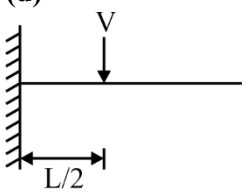
At '*y*' distance, shear stress q is same/uniform across width (*b*) of cross section. It is valid for any cross-section.

- Bending stress is assumed to be linearly varying in derivation of relationship of rate of change of bending moment being equal to shear force
- Material is considered homogenous and isotropic. Modulus of Elasticity is considered same for tension as well as compression



52. (?)

53. (d)



Maximum bending moment $= M = \frac{VL}{2}$

Maximum bending stress $(\sigma_{max}) = \frac{M}{Z} = \frac{VL}{2\frac{\pi}{32}D^3}$

$= \frac{16VL}{2\pi D^3}$

$\tau_{max} = \frac{4}{3}\tau_{average}$

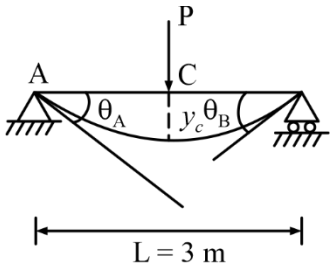
$= \frac{4}{3}\frac{V}{\frac{\pi}{4}D^2}$

Given $\tau_{max} = \frac{1}{2}\sigma_{max}$

$\Rightarrow \frac{16V}{3\pi D^2} = \frac{16VL}{2\pi D^3}$

$\Rightarrow L = \frac{2}{3}D$

54. (a)



$\theta_A = \theta_B = \frac{PL^2}{16EI} = 1° = 1 \times \frac{\pi}{180}$ radian

and $y_c = \frac{PL^3}{48EI}$

$\Rightarrow \frac{y_c}{\theta_A} = \frac{L}{3}$

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$$\Rightarrow \frac{y_c}{\theta_A} = \frac{L}{3}$$

$$\Rightarrow y_c = \theta_A \times \frac{L}{3}$$

$$= \left(1^\circ \times \frac{\pi}{180}\right) \times \frac{300}{3}$$

= 17.45 mm

55. **(*)**

as a rule, neglecting axial force, statically determinate real beams have statically determinate conjugate beams; and statically indeterminate real beams, become unstable conjugate beams. Although this occurs, the M/EI loading will provide the necessary equilibrium to hold the conjugate beam stable.

56. **(c)**

57. **(d)**

Wind forces are complex. The effect of wind on a building depends on the interaction of many variables. Natural variables include wind speed, wind height, ground surface features, and the properties of the air. Building variables include the shape, location, and physical properties of structures.

Alternate

The wind pressure intensity at any height of a structure depends upon

(i) the velocity and density of air,
(ii) shape and height of the structure,
(iii) topography of the surrounding ground surface,
(iv) the angle of wind attack and
(v) the roughness of the structure.

58. **(b)**

59. **(d)**

Principal of superposition

It may be stated as follows: The total displacement or internal loadings (stress) at a point in a structure subjected to several external loadings can be determined by adding together the displacements or internal loadings (stress) caused by each of the external loads acting separately. For this statement to be valid ft is necessary that a linear relationship exist among the loads, stresses, and displacements. Two requirements must be imposed for the principle of superposition to apply:

1. The material must behave in a linear-elastic manner, so that Hooke's law is valid, and therefore the load will be proportional to displacement.
2. The geometry of the structure must not undergo significant change when the loads are applied, i.e., small displacement theory applies. Large displacements will significantly change the position and orientation of the loads. An example would be a cantilevered thin rod subjected to a force at its end, causing ft to bend.

60. **(b)**

If the truss has b bars, r external reactions, and j joints, then if

$b + r < 2j$

$b + r \geq 2j$

unstable

unstable if truss support reactions are concurrent or parallel or if some of the components of the truss form a collapsible mechanism.

61. **(a)**

Truss

Assumptions for Design of truss

1. The members are joined together by smooth pins.
2. All loadings are applied at the joints

Because of these two assumptions, each truss member acts as an axial force member, and therefore the forces acting at the ends of the member must be directed along the axis of the member. If the force tends to elongate the member, it is a tensile force (T), whereas if the force tends to shorten the member, it is a compressive force (C). In the actual design of a truss it is important to state whether the force is tensile or compressive. Most often, compression members must be made thicker than tension

members, because of the buckling or sudden instability that may occur in compression members.

(a)

(b)

Cable

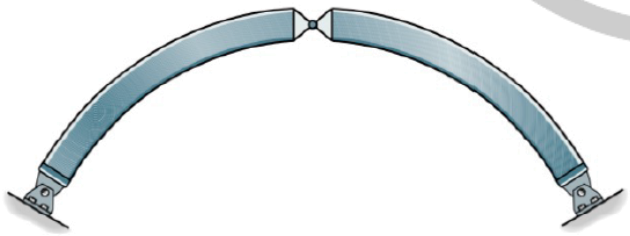
When deriving the necessary relations between the force in the cable and its slope, we will make the assumption that the cable is perfectly flexible and inextensible. Due to its flexibility, the cable offers no resistance to shear or bending and, therefore, the force acting in the cable is always tangent to the cable at points along its length

Arches

arches can be used to reduce the bending moments in long-span structures. Essentially, an arch acts as an inverted cable, so it receives its load mainly in compression although, because of its rigidity, it must also resist some bending and shear depending upon how it is loaded and shaped.

Three hinge Arch

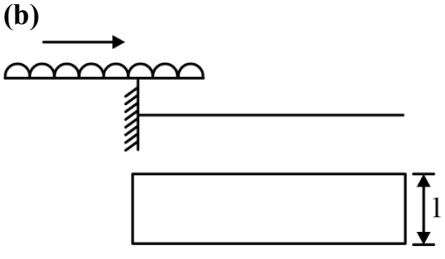
Three-hinged arches are statically determinate and can be analyzed by separating the two members and applying the equations of equilibrium to each member.



three-hinged arch

So, P–4, Q–3, R–1, S–2

62. (b)



(ILD)

Maximum shear can be derived by ILD concept.

- Maximum shear obtained when head of u.d.l placed at free end
- Shear force = f (Area of ILD

63. (?)

64. (?)

65. (?)

66. (?)

67. (?)

68. (?)

69. (?)

70. (?)

71. (?)

72. (?)

73. (?)

74. (?)

75. (?)

76. (b)

subjected to uniform stress. The strength of these members is influenced by several factors such as the length of connection, size and spacing of fasteners, net area of cross section, type of fabrication, connection eccentricity and shear lag at the end connection. To simplify the design procedure of tension members, considerable amount of research has been carried out (Salmon & Johnson 1996; Kulak & Wu 1997). This chapter discusses the effects of these parameters and the design of tension members as per IS 800.

77. (b)

Maximum Values of Effective Slenderness Ratios

Sl No.	Member	Maximum Effective Slenderness Ratio (*KI/r*)
(i)	A member carrying compressive loads resulting from dead loads and imposed loads	**180**
(ii)	A tension member in which a reversal of direct stress occurs due to loads other than wind or seismic forces	**180**
(iii)	A member subjected to compression forces resulting only from combination with wind/carthquakc actions, provided the deformation of such member does not adversely affect the stress in any part of the structure	**250**
(iv)	Compression flange of a beam against lateral torsional buckling	**300**
(v)	A member normally acting as a tie in a roof truss or a bracing system not considered effective when subject to possible reversal of stress into compression resulting from the action of wind or earthquake forces"	**350**
(vi)	Members always under tension' (other than pre-tensioned members)	**400**

Tension members, such as bracing's, pre-tensioned to avoid sag. Need not satisfy the maximum slenderness ratio limits.

p-3, Q-4, R-1, S-2

78. (d)

The design strength of the column depends on i.e fcd

And fcd depends on material of column, cross-sectional configuration, radius of gyration, buckling classes.

$$f_{cd} = \frac{f_y / \gamma_{m0}}{\phi + \left[\phi^2 - \lambda^2\right]^{0.5}} = x f_y / \gamma_{m0} \le f_y / \gamma_{m0}$$

Where

$\phi = 0.5\,[1 + \alpha\,(\gamma - 0.2) + \lambda^2]$

λ = non-dimensional effective slenderness ratio

$$= \sqrt{f_y / f_{cc}} = \sqrt{f_y (KL/r)^2 / \pi^2 E}$$

F_{cc} = Euler bucking stress = $\dfrac{\pi^2 E}{(KL/r)^2}$

The strength of a column depends on the following parameters:

- Material of the column
- Cross-sectional configuration
- Length of the column
- Support conditions at the ends (called restraint conditions)
- Residual stresses
- Imperfections

79. (d)

The failure of axially loaded column

1. Local buckling of members effect overall strength of member.
2. Squash load = fcd*Ag
3. Joint buckling

80. (c)

As per IS : 800-2007

Compression Element (1)		Ratio (2)	Class of Section		
			Class 1 Plastic (3)	Class 2 Compact (4)	Class 3 Semi-compact (5)
Outstanding element of compression flange	Rolled section	b/t_f	9.8ε	10.5ε	15.7ε
	Welded section	b/t_f	8.4ε	9.8ε	13.6 ε
Internal element of	Compression due to bending	b/t_f	29.3ε	33.5ε	42 ε

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compression flange					
	Axial compression	b/t_f	Not applicable		42ε

Circular hollow tube, including welded tube subjected to				
(a) moment	D/t	$42\ \varepsilon^2$	$52\ \varepsilon^2$	$146\ \varepsilon^2$
(b) axial compression	D/t	Not applicable		$88\varepsilon^2$

81. (c)

Angles- Roof purlin and sheeting rail Rolled I-Section- most frequently used as a beam Castellated beams-Long spans and light loads Plate girders – Long spans and heavy loads

82. (c)

As per IS:800-2007

(1) The beam has no initial imperfection and its behaviour is elastic.

(2) It is loaded by unequal and opposite end moments in the plane of the web.

83. (b)

Vertical stiffener are provided to prevent buckling of web due to diagonal compression not to satisfy any deflection limitation

84. (c)

The behavior of beam-columns subject to bending about the minor axis is similar to that subjected to major axis bending, but for the following differences:

1. In the case of slender members under smaller axial load, there is very little reduction of moment capacity below Mp, since the lateral torsional buckling is not a problem in weak axis bending.
2. The moment magnification is larger in the case of beam-columns bending about the weak axis.
3. The failure of short/stocky members is either due to section strength being reached at the ends (under smaller axial load) or at the section of larger magnified moment (under larger axial load).
4. The failure of even slender members is due to buckling about the weak axis only and no torsional deformation is experienced.

85. (b)

As per IS 875-3:2015

For wind angle = 90 degrees:

Zone/Surface	C_{pe}
Zone A – Windward wall	– 0.5
Zone B – Leeward wall	– 0.5
Zone C – Sidewall	+0.7
Zone D – Sidewall	–0.1
Local zone (0.25w from edge)	–1.1

86. (a)

1. The stress-strain properties do not remain constant throughout the section.
2. Residual stresses due to cooling after rolling the steel section and those imposed by welding during construction exist in the section before loading.

87. (a)

The assumed hinge should be modified (an indication of this will be provided by bending moments determined in the statical analysis) and the analysis repeat. The use of the mechanism and equilibrium methods of plastic analysis in sin span beams is explained in Examples 4.6-4.10.

A load factor of 1.7 is normally used in plastic design.

88. (b)

89. (a)

When the specific gravity is known,

We use Pycnometer method to determine water content of the soil

90. **(c)**
Aeolian soil is a wind transported soil

91. **(a)**

As per Stokes' law,

$$V = \frac{1}{18}\left(\frac{\gamma_s - \gamma_t}{\mu_t}\right)D^2$$

92. **(?)**

93. **(d)**
Thixotropy is property by virtue of which loss of shear strength on remoulding can be regained if the soil is left undisturbed for some time, at constant water content.

94. **(a)**
H → Total Head

$$H = \underbrace{\frac{P}{\gamma_w}}_{\text{Pressure head}} + \underbrace{Z}_{\text{datum head}} + \underbrace{\frac{V^2}{2g}}_{\text{Velocity head}}$$

$\frac{V^2}{2g}$ is neglected since velocity of flow is generally very small.
P → Pore water pressure (Positive or negative)
Flow always occurs from higher head to lower head.

95. **(b)**

Soil	Gravel	Sand	Silt	Clay
K mm/s	> mm/s	$10–10^{-2}$ mm/sec	$10^{-2} – 10^{-5}$ mm/	$< 10^{-5}$ mm/sec

96. **(d)**

$$S_i = \frac{qB\left(1-\mu^2\right)}{E} J_g$$

$$S_i = \frac{180\times18\times\left(1-0.5^2\right)\times1}{45\times10^3}\times10^3 = 54 \text{ mm}$$

97. **(c)**
The maximum gross intensity of loading that the soil can support before it fails in shear is called the ultimate bearing capacity (q_u)

98. **(d)**

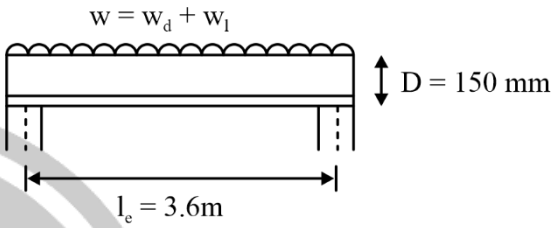
$$S_i = \frac{q\cdot B\left(1-v^2\right)}{E_s}.I_t$$

$$S_i = \frac{q\cdot B\left(1-\mu^2\right)}{E}.I_g$$

99. **(a)**

100. **(c)**

101. **(d)**



$W_d = 25 \times (1 \times 1 \times 0.15) = 3.75 \text{ kN/m}^2$

$W_l = 3 \text{ kN/m}^2$

For serviceability,

Load, $w = w_d + w_l = 6.75 \text{ kN/m}^2$

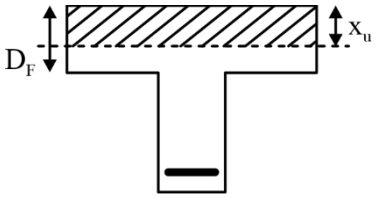
Shear,

$$V = \frac{wl}{2} = \frac{6.75\times3.6}{2} = 12.15 \text{ kN/m}$$

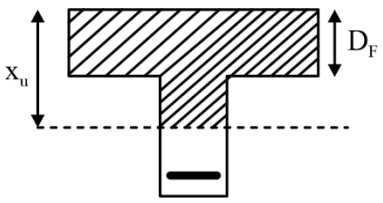
Design shear,

$V_u = 1.5 \times 12.15 = 18.225 \text{ kN/m}$

102. **(c)**



- If $x_u \le D_F$ → N.A. is within flange and compressive force is in flange only.



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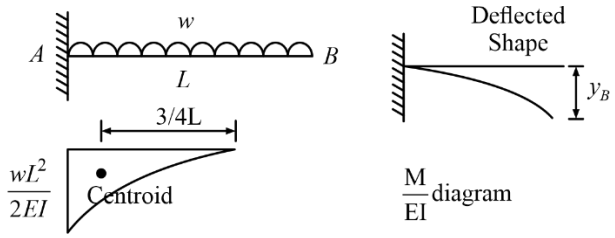
- If $x_u > D_F$ or only $D_F < \frac{3}{7}x_u \rightarrow$ compressive stress in flange is uniform.
- If $x_u > D_F$ and $D_F > \frac{3}{7} \times x_u \rightarrow$ compressive stress in flange is non-uniform.

Only statements (1) and (2) are correct.

103. (c)



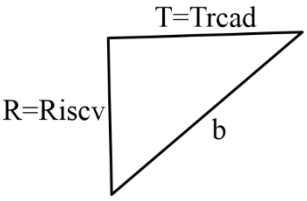
$y_B - y_A$ = Area moment of $\frac{M}{EI}$ diagram about B

$$= \left(\frac{1}{3}\frac{wL^2}{2EI} \times L\right) \times \left(\frac{3}{4}L\right)$$

$$= \frac{wL^4}{8EI}$$

$$\Rightarrow y_B = \frac{wL^4}{8EI} (\text{Since } y_A = 0 \text{ at fixed end})$$

104. (b)



b = width of slab along slant dimension.

$$b = \sqrt{R^2 + T^2}$$

105. (a)

As per R4.6 of ACI-318R and as per 4.6.2,

Design strength (ϕS_n) ≥ Required strength (U)

Also as per ACI-318,

Design moment (ϕM_n) ≥ Required moment (M_u)

106. (c)

In the conveying of most building concrete from the mixer or truck to the form is done in bottom-dump buckets, then the chief danger during conveying is that of segregation.

107. (d)

108. (a)

As per ACI-209, Equation 2-8,

$$C_{ct} = \frac{t^{0.6}}{10 + t^{0.6}} C_{cu}$$

109. (?)

110. (c)

Minimum thickness for non-prestressed one way slabs (As per ACI-318, Table 7.3.1.1)

$h_{min} = \frac{L}{20}$ as $\left(\frac{l}{d} \le 20\right)$ for deflection criteria.

111. (c)

Maximum bending moment,

$$M = \alpha . q . l^2$$

$$\alpha = \frac{\left(\frac{l_u}{l_x}\right)^4}{8\left(1 + \left(\frac{l_y}{l_x}\right)^2\right)}, \text{ put } \frac{l_y}{l_x} = 1$$

$$\alpha = \frac{\left(\frac{l_u}{l_x}\right)^4}{8\left(1+1^2\right)} = \frac{1}{16} = 0.0625$$

$$\boxed{M = 0.0625 . q . l^2}$$

112. (b)

As per ACI-318, the load factor for stem against lateral earth pressure is 1.6.

113. (d)

Aerial camera:mainly used in topographic surveys, but also for recording the shapes (and subsequent deformations) of buildings.

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Satellite camera: Essentially, a long-range aerial camera. Satellites can be used for gathering topographic data, and also for many other remote sensing purposes related to geographic information systems (GIS), such as monitoring crop yields or atmospheric pollution.

Electromagnetic distance measurement (EDM) devices: Typically used for measurements of lengths from, say, 5 m to 5 km, though some instruments have ranges up to about 25 km.

GPS—Navigational satellites are used to fix positions on the earth. This technique has almost completely replaced terrestrial triangulation for large-scale control survey, and can also be useful on building sites, provided it is not set up close to buildings or trees.

114. (c)

Correction for standardisation also called as correction for absolute length

$$C_a = \frac{C}{l} \times L$$

$$= \frac{\text{Actual length}}{\text{Nominal length}} \times \text{Measured length}$$

Correction for sag

$$C_g = -\frac{W^2 L}{24P^2}$$

Correction for Misalingment

$$C_m = \frac{-h^2}{2L}$$

115. (a)

Sensitivity of Bubble tube

$$\alpha' = \frac{d}{R} = \frac{S}{nD}$$

$$30 = \frac{S}{2.5 \times 200} \times 206265$$

$$S = \frac{30 \times 2.5 \times 200}{206265} = 0.0727\text{m}$$

S = 0.073 m

116. (a)

Culminate on Transit: When a celestial body crosses the observer's meridian

Vernal Equinox: It is an instant on about on 21th March, the axis of the earth is perpendicular to the line joining the earth and the sun. The sun is in the plane of the equator & passes it from south to north. Also called "First point of Aries".

Celestial Pole: The point of which the polar axis, when produced, intersects the celestial sphere.

Obliquity: It is axial tilt in simple words. In astronomy plane of an ecliptic is inclined to that of equator by about 23°27' is known as "obliquity of ecliptic".

117. (b)

Any celestial body may be located on the celestial sphere by the spherical coordinates, right ascension and declination. Then values, for a celestial body, although nearly constant, are not absolutely so. This is mainly because of precession and nutation. The slow secular movement of the plane of the equator because of the disturbing couple due to the attractions of the sun. moon, and planets on the earth's surface (not spherical) is known as "Precession". On the other hand. Nutation results because of the variation in the value of this couple, the effect being very small. Both of them cause a variation in the position of the equator and the "first point of aries" and consequently the declination and right ascension of a star undergo slow alteration. A further source of error in the magnitude of declination or right ascension is from the fact that the stars do not occupy fixed positions on the celestial sphere. The variation is more for the sun than for the stars.

118. (b)

In reciprocal levelling we can eliminate error due to curvature, refraction and collimation. Hence it will lead to more accurate geodetic survey.

119. (b)

The main advantage of GPS is that it can be used in any weather conditions day or night. This enables GPS surveying to be carried out over extended periods at any time of the year without restrictions such as rain, fog and poor visibility. Another advantage when surveying with GPS is that inter visibility between stations or points surveyed is .not necessary.But high cost of GPS surveying has restricted the realization of the full potential of GPS till date. Added to this, there are difficulties in defining heights above datum's such as mean sea level and with real time data processing and control.

120. (b)

There are some disadvantages to remote sensing surveys:

1. Different types of land use may not be distinguishable on Images.
2. Most images lack the horizontal perspective that is valuable for identifying many categories of land use.
3. For surveys of small areas, the cost of mobilising a remote sensing mission may be Uneconomical

Hence remote sensing interpretations should be supplemented by ground checks of areas that represent various categories of land cover.

121. (a)

Main advantages of aerial photogrammetry are the speed with which an area is covered, the ease with which topography of inaccessible areas can be detailed, no possibility of omitting any field data, the tremendous amount of details shown and economy.

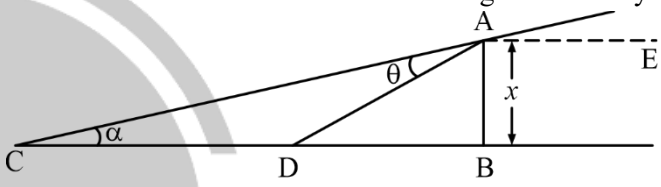
122. (b)

Region	Wavelength
Gramma ray	< 0.03 nm
X-ray	0.03-0.4 μm
Ultraviolet	0.3-0.4 μm
Photographic UV band	0.3-0.4 μm
Visible	0.4-0.7 μm
Infrared	0.7-1.0 μm
Reflected IR band	0.7-3.0 μm
Thermal IR band	3-5 μm 8-14 μm
Microwave	0.1-30 cm
Radar	0.1-30 cm
Radio	> 30 cm

123. (d)

Weisbach Triangle Method

Since line joining the two suspended wires gives the direction of the centre line, accurate setting can be achieved only if the theodolite can be set out exactly in the line with the wires. The operation is quite difficult and time consuming, and requires several trials. An alternative method, also known as Weisbach triangle method, may be used to connect surface and underground survey.



The Weisbach Triangle

124. (a)

External distance is also called as Apex distance.

$E = R (\sec \Delta/2 - 1)$

125. (?)

126. (d)

Importance of Specification:

(i) It clearly states the quality of materials, the workmanship desired and the method of doing the work. It enables the contractor to quote correct rates for the works.

(ii) It serves as a guide to the contractor as well as to the supervising staff during construction and execution of work.

(iii) It also serves as legal instrument and evidence in case of disputes.

(iv) It checks the strength or quality of work involved in a project.

(v) It gives detailed information regarding the equipment, tools and plants to complete the

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project which enables us to procure them before hand in time.

(vi) As the cost of work directly depends on its specifications, it gives correct idea about the estimated cost, and funds can be arranged accordingly.

127. (a)

Grass rent = [800 × 12] = 9600 per year

Outgoings = 18% Gross rent = (0.18 × 9600) = 1728

∴ Net rent = [gross rent – outgoings] = [9600 – 1728] = 7872 per year.

∴ Capitalised valve = [Net rent × year's purchese]

$$= \left[7872 \times \frac{1}{0.08}\right] = Rs.98,400$$

128. (b)

Lump sum Contract:

n this contract a single lump sum is quoted for the job and is accepted as a fixed price. This will be possible only when all the details of the work is presented in the drawings so that the contractor may work out the exact price of the structure. Sometimes a bill of quantity is also attached to help the contractor to have a better picture of the job and sometimes a schedule of rate is also presented which may be used in pricing the variations in quantities.

This contract is better suited for over ground jobs and not so much for structures below ground as overground structures are always visible and quantities could be measured at any time.

This is found to be very effective when

1. The job is comparatively small
2. The job is precisely and exactly described in all details.
3. There is not much risk attached to its construction, i.e. there may not be any hazard which could not be visualised beforehand.
4. Alterations are kept to the minimum.

The major advantages of this contract are:

1. It avoids a lot of detailing and accounting thereby making the job easy.
2. It offers the owner a fixed total price and the owner is happy with it.
3. The contractor gets a chance to do the work without much hindrance. The disadvantages may be stated as:

1. It becomes difficult to accommodate additions, alterations of design and specifications.
2. In case of unforeseen hazards during construction, the contractor is put to unlimited hardship.

Even in case of a bill of quantity or an item rate contract, there are sometimes items which are asked to be quoted as lump sum. This saves a lot of work as otherwise the break-up of such items is to be given and each of the sub-items is to be priced separately.

NOTE: Lump sum contract works better for mechanical and electrical installations than in civil engineering construction.

129. (c)

For the following reasons, the contractor attains the right to terminate:

(a) If the work is stopped by a court order for three months or more for any reason;

(b) If the architect/consultant fails to issue the certificate of payment after the stipulated period;

(c) If the owner fails to pay the contractor after the stipulated period of certification for the payment from the consultant or the arbitrator. The contractor in such cases after serving due notice to the owner and the architect may stop all work and recover from the owner payment for all work executed, any loss sustained upon any plant or material and reasonable profits and damages.

130. (b)

131. (a)

The contractor has to maintain all records of action taken under the provision of insurance of the contract and other state and central laws in connection with insurance benefits for the labourers.

The following records are essentially maintained:

1. Workmen's compensation and employer's liability insurance in accordance with applicable laws;
2. Comprehensive general liability insurance to cover both body and property damage;
3. Comprehensive automobile liability insurance to cover both body and property damage;
4. Fire insurance to cover materials, tools, equipment, supplies, temporary and permanent structures.

132. (d)

Z Test formula:

$$\text{Z Test} = \frac{(\bar{x}-\mu)}{\left(\frac{\sigma}{\sqrt{h}}\right)}, \text{ where}$$

$\bar{x}$ = mean of sample

μ = Mean of population

σ = standard deviation of population

n = Sample size

Given, $(\bar{x}-\mu)=0.5, \sigma=1.8, Z=1.96$

$$\Rightarrow 1.96=\frac{0.5}{\left(\frac{1.8}{\sqrt{n}}\right)} \Rightarrow \boxed{n=49.787\approx 50}$$

133. (c)

- Assuming the number of workers active is normally distributed,

Number of observations required

$$(N)=\frac{Z^2\times P\times(1-P)}{L^2}$$

Where,

Z = standard deviate

For 95% $\rightarrow$ z = 1.96

given

P = % of idle = 20% = 0.2

L = confidence limit = 5% = 0.05

$$\therefore \quad N=\left[\frac{(1.96)^2\times 0.2\times(1-0.2)}{(0.05)^2}\right]=245.86\approx 276$$

134. (d)

The load capacity of a crane depends on:

1. The stability of the footing: The size of the crawlers is a factor because a longer or wider mounting increases the stability of any footing.
2. The strength of the boom: This is one of the major governing factors in establishing load ratings, and these should never be exceeded. Ratings vary with the boom length, and any extension of the boom reduces the rating. Lowering the boom also increases the clearance radius and thus reduces the rated capacity.
3. The counterweight: This is added to the after-end of the machine. Manufacturer's specifications provide standard and maximum counterweights and also the crane ratings. Counterweights may be increased to,a specified maximum, but the operating radius must not exceed that given by the manufacturer.

The working range of a crane is limited horizontally for the maximum lift only by the boom length. The reach below the footing level is limited only by the length of the hoist cable.

135. (a)

136. (c)

Water

Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may he deleterious to concrete or steel.

Potable water is generally considered satisfactory for mixing concrete. As a guide the following concentrations represent the maximum permissible values:

a) To neutralize 100 ml sample of waler, using phenolphthalein as an indicator, it should not require more than 5 ml of 0.02 normal NaOH. The details of test arc given in 8.1 of IS 3025 (Part 22).

b) To neutralize 100 ml sample of water, using mixed indicator, it should not require more than 25 ml of 0.02 normal HjSO4. The details of test shall be as given in 8 of IS 3025 (Part 23).

c) Permissible limits for solids shall be as given in Table I.

Table 1 Permissible Limit for Solids (Clause 5.4)

S No.		Tested as per	Permissible Limit Max
i)	Organic	IS 3025 (Part 18)	200 mg/l
ii)	Inorganic	IS 3025 (Part 18)	3000 mg/1
iii)	Sulphates (as SO,)	IS 3025 (Part 24)	400 mg/l
iv)	Chlorides (as CI)	IS 3025 (Part 32)	2.000 mg/l for concrete not containing embedded steel and 500 mg/l for reinforced concrete work
v)	Suspended matter	IS 3025 (Part 17)	2000 mg/1

137. (c)

138. (a)

139. (c)

Median widths

1.2 m → pedestrian Purpose Refuge (40 feet)

Am to 12 m → crossing

As per IRC.86 Cl.56

140. (a)

$$V_d t + \frac{V^2}{254(f \pm G)}$$

$$SSD = 1.468\ V_d t + \frac{V^2}{30\left[\frac{9}{32.2}\right] + G}$$

141. (d)

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

$$R_{\min} = \frac{V^2}{15(e_{\max} + f)}$$

$$R_{\min} = \frac{V^2}{15(0.01e_{\max} + f)}$$

Alternate

$$e_{ef} = \frac{V^2}{127R} = \frac{V^2}{gR}$$

1. mpn = 1.6093 kmph

142. (c)

143. (c)

$$VDE = \frac{N_1\left[\frac{L_1}{L_S}\right]^4 + N_2\left[\frac{L_2}{L_S}\right]^4 + \ldots N_n\left[\frac{L_n}{L_S}\right]}{\text{Number of Commericial vehicle}}$$

144. (c)

VDF is a multiplier to convert the number commercial vehicle of different axle loads and axle configuration to number of standard axle load repetitions.

145. (c)

Maintenance cost of Tunnel is competency less to Briclarge

When soil strata of hill are soft then we cannot provide tunnel there and choice remains only an open cut.

146. (b)

Circular

Elliptical → For causing water

Horseshoe

Circular: Used to carry water under pressure not used for traffic load as more filling is needed to make the base flat provides the greatest cross-section for least perimeter.

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Eliptical: For carrying water, this section is narrow at shape so cannot used for traffic.
Eggshaped: Suitable to carry sewage.

147. (a)

Full Face Method: In this method, the full face or entire façade of tunnel is tackled at same time. In this mucking track is laid once for full operation.
Heading and bench method is suitable if tunnel section is very large and bedrock is soft and unstable.

148. (?)

149. (d)

150. (b)

GATE WALLAH

SOLDIERS

THANK YOU