Q 1 Identify the correctly matched pair(s) from the following based on the type of cut-back bitumen and fluxing agents used.

1. Rapid curing (RC) cut-backs: Kerosene
2. Medium curing (MC) cut-backs: Naptha or gasoline
3. Slow curing (SC) cut-backs: light oils

(A) Only 3   (B) Only 1

(C) Only 1 and 2   (D) Only 1 and 3

Q 2 Select the option that is correct regarding the following two statements, labelled as Assertion (A) and Reason (R) with respect to permeability of soil.

Assertion (A): Permeability of soil continues to decrease with the increase in dry density of compacted soil

Reason (R): Soil and water are compressible in nature.

(A) A is false, but R is true.

(B) Both A and R are true, but R is not the correct explanation of A

(C) A is true, but R is false.

(D) Both A and R are true and R is the correct explanation of A.

Q 3 Match the angles under List-1 (whole circle bearings) with their corresponding values under List 2 (quadrantal bearings).

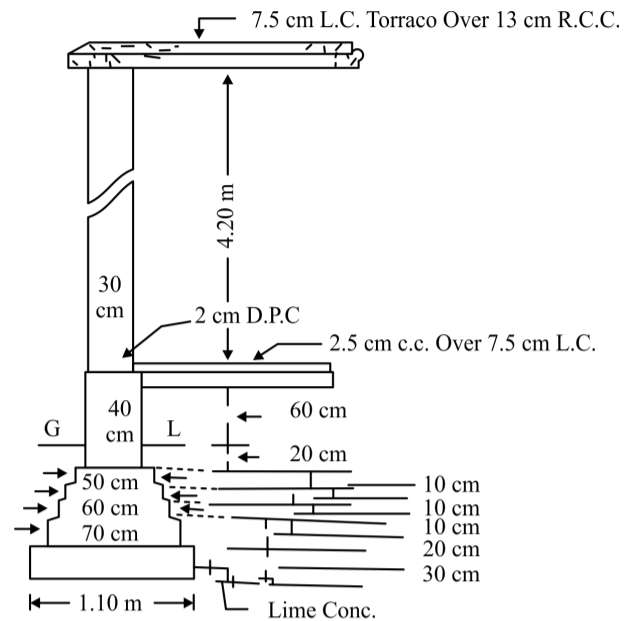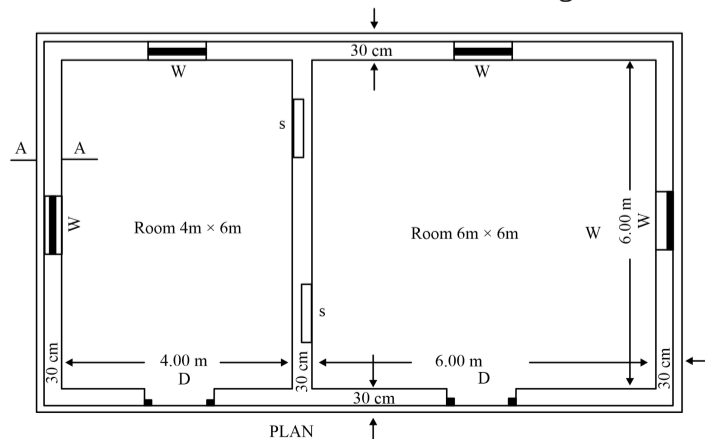| List-1	List-2
P. 144°30'	1. S 54°30' E
Q. 215°30'	2. N 35°30' W
R. 125°30'	3. S 35°30' W
S. 324°30'	4. S 35°30' E

(A) P–3, Q–2, R–1, S–4

(B) P–2, Q–3, R–4, S–1

(C) P–4, Q–3, R–2, S–1

(D) P–4, Q–3, R–1, S–2

Q 4 Hirakud Dam is built across

(A) Yamuna River   (B) Kaveri River

(C) Mahanadi River   (D) Krishna River

Q 5 A two-roomed building is shown in the figure Calculate the quantity of lime concrete foundation (PCC).

The width of PCC 1.1 m is mentioned in figure.

PLAN

CROSS SECTION OF WALL ON AA

(A) 9.56 m^3 (B) 14.66 m^3

(C) 12.94 m^3 (D) 10.55 m^3

Q 6 The gross bearing capacity of a strip footing 1.5 m wide located at a depth of 1.2 m in clay is 420 kN/m². If the unit weight of the soil is 20 kN/m³, estimate the net bearing capacity in kN/m² units.

(A) 366   (B) 396

(C) 390   (D) 400

Q 7 A column with length 'b' and breadth 'd' is subjected to an eccentric point load 'P' (eccentric in the direction of breadth) with an eccentricity 'e'. Calculate the bending stress developed.

(A) $\dfrac{3\,Pe}{bd^2}$ (B) $\dfrac{6\,Pe}{bd^2}$

(C) $\dfrac{24\,Pe}{bd^2}$ (D) $\dfrac{12\,Pe}{bd^2}$

Q 8 Identify the correct pairs from the following with respect to the minimum roadway width in mountainous and steep terrain.

Road Type	Minimum Road Way Width
Single-lane major district roads	5.75 m
Single-lane other district roads	4.75 m
Single-lane village roads	4.00 m

(A) 1, 2 and 3   (B) Only 2 and 3

(C) Only 1 and 2   (D) Only 1 and 3

Q 9 As per IS 456:2000, the pH value of water used for mixing and curing of cement concrete shall NOT be less than

(A) 7.5   (B) 6

(C) 8.5   (D) 5

Q 10 A timber test specimen of size 50 × 50 mm cross-section and 150 mm length was tested for its specific gravity. If the specimen weighs 250 gm and has 15%

of moisture content, calculate its specific gravity by accounting the moisture content.

(A) 0.625   (B) 0.667

(C) 0.596   (D) 0.567

Q 11 Study the given statements (P, Q) pertaining to propagation of sound waves and select the most appropriate option with respect to the correctness of the statements.

P. Sound propagation from one point to another point is governed by Sabines' formula.

Q. In air, sound propagates as longitudinal waves.

(A) Neither P nor Q

(B) Both P and Q

(C) Q only

(D) P only

Q 12 Consider the below statements with respect to asbestos and identify the correct option.

Statement A: When asbestos is heated below 550°C, asbestos loses its elasticity and strength and becomes brittle but restores its properties on cooling.

Statement B: Asbestos molecules are strongly bound together only in one direction, whereas the lateral bond with adjacent molecules is quite weak.

(A) Statement A is correct, and statement B is incorrect.

(B) Statement B is correct, and statement A is incorrect

(C) Both statements are incorrect

(D) Both statements are correct

Q 13 Consider the below statements with respect to hydraulic pumps and identify the correct option.

Assertion (A): Reciprocating pumps are used for lifting oils from deep wells, as it can build up very high pressure.

Reason (R): Discharge capacity of a reciprocating pump is much greater than that of a centrifugal pump.

(A) Both A and R are true, and R is the correct explanation of A.

(B) A is true but R is false.

(C) Both A and R are true, but R is not the correct explanation of A.

(D) A is false but R is true.

Q 14 Identify the instrument shown in the figure below, which is used for finding the shear strength of soil.
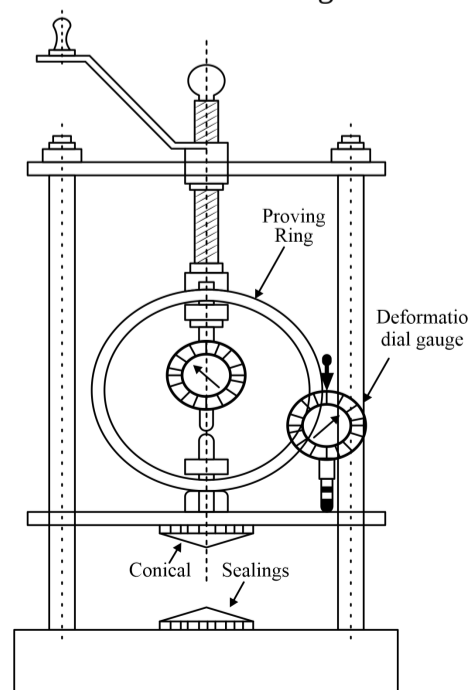
(A) Unconfined compression test apparatus

(B) Tri-axial shear test apparatus

(C) Direct shear test apparatus

(D) Vane shear test apparatus

Q 15 Calculate the theoretical weight of a steel bar of length 8 m and diameter 20 mm. Take density of steel as 7850 kg/m^3.

(A) 19.72 kg   (B) 12.56 kg

(C) 15.58 kg   (D) 17.77 kg

Q 16 Which of the following types of canal is aligned roughly at right angles to the contours of the country ?

(A) Ridge canal   (B) Water shed canal

(C) Side slope canal   (D) Contour canal

Q 17 Identify the INCORRECT statement about prismoidal formula used to compute earthwork.

(A) The ratio of volume calculated by end area formula and the prismoidal formula is called as the 'Prismoidal correction'.

(B) If there is an even number of cross sections, the end strip must be treated separately, and volume between the remaining sections may be calculated by prismoidal formula.

(C) Prismoidal formula is also known as Simpson's rule for volume.

(D) It is necessary to have an odd number of cross-sections to apply prismoidal formula.

Q 18 Match the following.

List-I	List-II
1. Storm water inlets	a. Provided to admit the surface runoff to sewers.
2. Catch basins	b. Provided at the head of sewers
3. Flushing manholes	C. Provided to stop the entry of heavy debris present in the storm water into sewers.

(A) 1-c, 2-b, 3-a   (B) 1-a, 2-c, 3-b

(C) 1-a, 2-b, 3-c   (D) 1-c, 2-a, 3-b

Q 19 Identify the correct pairs from the following with respect to the manufacturing techniques of different types of cement

1. Quick setting cement: Use of reduced gypsum content as compared to that used in ordinary Portland cement.

2. Low heat cement: Use of reduced C_2S content as compared to that used in ordinary Portland cement.

3. Sulphate resistant cement: Cement with C_3A content not more than 5%

(A) Only 2 and 3   (B) Only 2 and 3

(C) Only 1 and 3   (D) Only 1 and 2

Q 20 Calculate the slope at the free end of a cantilever beam of length l = 5 m subjected to a uniformly varying load with intensity varying from 0 kN/m (at B) to 20 kN/m (at A) as shown in the figure. Consider that the flexural rigidity (EI) of the beam is constant throughout its length.
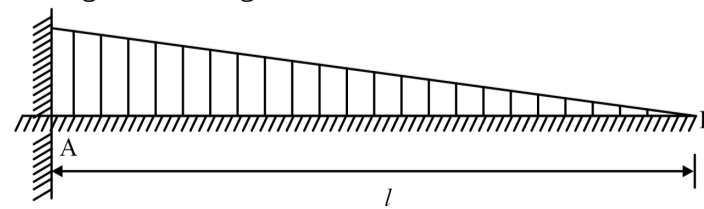

(A) $\frac{129.27}{EI}$ (B) $\frac{64.64}{EI}$

(C) $\frac{104.16}{EI}$ (D) $\frac{88.58}{EI}$

Q 21 As per IS-456-2000, for ultimate limit states, the partial factor of safety assigned for concrete is
(A) 1.5   (B) 1.15
(C) 0.36   (D) 0.87

Q 22 Consider the following statements with respect to the maximum thickness of particle boards and identify the correct option.
Statement A: As per IS 3129:1985, the maximum thickness of low-density particle boards shall be 50 mm.
Statement B: As per IS 3129: 1985, the maximum thickness of insulation particle boards shall be 40 mm.
(A) Both the statements are correct.
(B) Statement B is correct, but statement A is incorrect.
(C) Both the statements are incorrect.
(D) Statement A is correct, but statement B is incorrect.

Q 23 Consider the following statements with respect to the effects of water logging on agricultural land and identify the correct option.
Statement A: Water logging increases the activity of soil bacteria.
Statement B: Water logging leads to growth of wild flora.
(A) Both the statements are correct.
(B) Statement A is correct, but statement B is incorrect.
(C) Statement B is correct, but statement A is incorrect.
(D) Both the statements are incorrect.

Q 24 Locate the centroid with respect to base AB of a rectangular section shown in the figure. Consider that a part of the circular section with diameter 150 mm is removed.
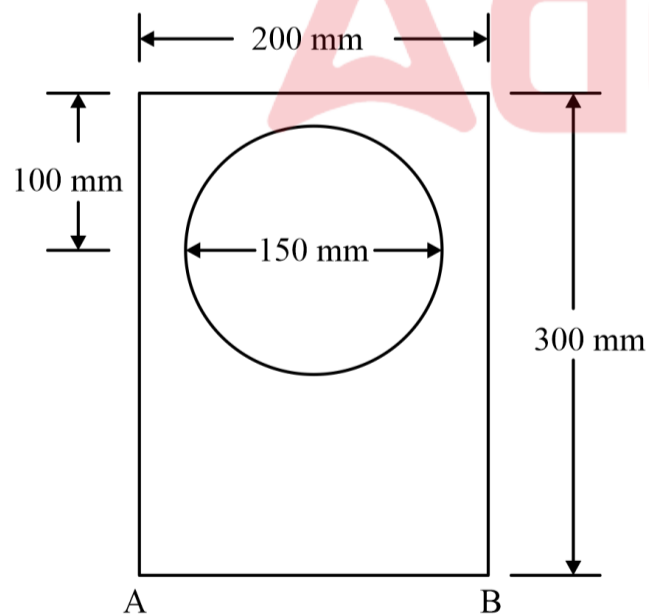
(A) 129.1 mm   (B) 133.68 mm
(C) 154.9 mm   (D) 112.44 mm

Q 25 Study the given statements P and Q, based on the plasticity index of soils and select the most appropriate option with respect to the correctness of the statements.
P. The plasticity index of a soil is measure of the amount of clay in the soil.
Q. When silt is added to clay, the plasticity index of the resulting soil increases.
(A) Both P and Q   (B) Q only
(C) Neither P nor Q   (D) P only

Q 26 Which of the following is an INCORRECT statement with respect to the characteristics and design factors of rigid and flexible pavements?
(A) Rigid pavements do not get deformed to the shape of the supporting layer below it.
(B) The lower layers of flexible pavements face stresses of lesser magnitudes as compared to the pavement surface directly under the wheel load.
(C) The flexible pavement layers may reflect nonrecoverable as well as recoverable deformations of the lower layers, including the sub-grade onto the upper layers and also the pavement surface.
(D) The stresses in rigid pavements are analyzed by using the plastic theory, assuming that the pavement is resisting over a rigid surface.

Q 27 Identify the INCORRECT statement with respect to different types of pipe flow.
(A) The fluid characteristics like velocity, density and pressure at a point do not change with time in case of steady flow.
(B) The flow in a circular pipe is categorized as laminar when the Reynolds number for the flow is less than 4000.
(C) The velocity of the flow at any given time does not change with respect to space in case of uniform flow.
(D) The type of flow in which the fluid particles move along a well-defined streamline or math's such that all the streamlines are straight and parallel to each other is known as laminar flow.

Q 28 Consider the below statements with respect to cement concrete and identify the correct statement(s)
i. Size and shape of aggregates used in making concrete influence the workability of concrete.
ii. As the water cement ratio in making concrete increases, the strength of concrete increases.
iii. Maturity of concrete is independent of temperature at which it is cured.
(A) i and iii   (B) i and ii
(C) Only i   (D) Only ii

Q 29 A person constructed a warehouse at a cost of Rs. 4,00,000, excluding the cost of land. The warehouse will become obsolete after 10 years. Find the amount of sinking fund to be annually deposited at the rate of 5% compound interest. The scrap value of the warehouse is 10% of the cost of purchase.
(A) Rs. 32,502   (B) Rs. 28,622
(C) Rs. 30,800   (D) 25,980

Q 30 In the design of a two-way slab, the flexural reinforcement required in a shorter span is found to be 200 mm^2/m. Calculate the required spacing if steel bars of diameter 8 mm are to be used. Ignore the spacing of reinforcement based on other criteria's and calculate only based on the given information.
(A) 251.32 mm   (B) 194.65 mm
(C) 267.23 mm   (D) 236.87 mm

Q 31 Calculate the limiting moment of resistance in accordance with the limit state design of singly reinforced rectangular beam whose width is 200 mm and effective depth is 400 mm. Consider that the grade of steel is Fe415 and that of concrete is M20.

(A) 88.30 kN-m   (B) 69.98 kN-m

(C) 75.96 kN-m   (D) 96.52 kN-m

Q 32 Identify the type of lacing/batten system shown in the figure below.
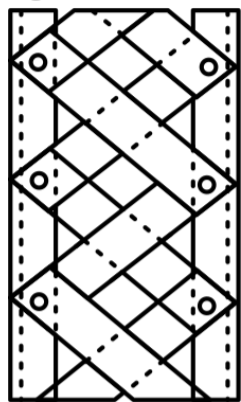
(A) Single flat batten intersecting

(B) Double flat batten intersecting

(C) Single flat lacing intersecting

(D) Double flat lacing intersecting

Q 33 As per IS 10262:2019, what is the approximate amount of entrapped air to be expected in normal (non air-entrained) concrete when 10 mm nominal maximum size of aggregate is used in making concrete?

(A) 2.0   (B) 1.5

(C) 0.8   (D) 0.5

Q 34 The following bearings were taken in a closed compass traverse.

Line	Fore bearing	Back bearing
AB	80°10'	259°0'
BC	120°20'	301°50'
CD	170°50'	350°50'
DE	230°10'	49°30'
EA	310°20'	130°15'

Calculate the corrected fore bearing of line 'DE' by assuming that the observed bearing of line 'CD' is correct.

(A) 230°5'   (B) 230°15'

(C) 229°55'   (D) 230°10'

Q 35 The rainfall on five successive days on a catchment was 2,6,9,5 and 3 (in cm units). If the ϕ index for the storm is taken as 3 cm/day, the total direct runoff from the catchment will be:

(A) 20 cm   (B) 22 cm

(C) 11 cm   (D) 10 cm

Q 36 As per IS soil classification, if the coefficient of uniformity of a soil sample is greater than 6 and the coefficient of curvatures lies between 1 and 3, the soil is classified as

(A) GC   (B) GW

(C) SM   (D) SW

Q 37 Study the given estimates for the construction of a proposed hospital building and identify the estimate that does not belong to the category of preliminary estimates.

(A) Estimate on the basis rate per unit length of wall and length of walls of hospital

(B) Estimate on the basis of rate per bed, and number of beds in the hospital

(C) Estimate on the basis of the plinth area unit rate and plinth area of hospital

(D) Estimate on the basis of each item of the work in the building and their respective unit rates

Q 38 Which of the following constant factors relates stress in the steel linearly with stress in adjoining concrete?

(A) Young's modulus

(B) Shear modulus

(C) Poisson's ratio

(D) Modular ratio

Q 39 In the design of RCC structures, the limit state of collapse deals with

(A) Leakage of water in the structure

(B) Loss of durability

(C) The strength of the structure under the maximum design load

(D) Discomfort caused by excessive deflection

Q 40 Select the option that is correct regarding the following two statements, labelled as Assertion (A) and Reason (R), with respect to characteristic features of contour lines.

Assertion (A): A single contour cannot split into two lines.

Reason (R): A knife-edge ridge or depression does not occur in nature.

(A) Both A and R are true, but R is not the correct explanation of A

(B) A is true, but R is false

(C) Both A and R are true and R is the correct explanation of A.

(D) A is false, but R is true.

Q 41 Identify the type of weld made between two plates shown in the figure below.

(A) Continuous fillet weld

(B) Flat fillet weld

(C) Groove weld

(D) Lap weld

Q 42 As per IS 800:2007, what is the maximum slenderness ratio for tension members (e.g. tie in roof truss) and subjected to reversal of stresses due to action of the wind or earthquake forces?

(A) 180   (B) 280

(C) 450   (D) 350

Q 43 The value of speed ratio of a Pelton wheel turbine varies from

(A) 0.78 to 0.85   (B) 0.62 to 0.77

(C) 0.43 to 0.48   (D) 0.5 to 0.98

Q 44 Match the following with respect to imposed floor loads for different occupancies as specified in IS 875 (part 2)-1987.

Occupancy Classification	Uniformly distributed
1. Balconies of dwelling houses	a. 2 kN/m^2
2. All rooms and kitchens of dwelling houses	b. 4 kN/m^2
3. Dining rooms, cafeterias and restaurants	c. 2.5 kN/m^2

in hotels, hostels and boarding houses.	
4. Office rooms in hotels, hostels and boarding houses.	d. 3 kN/m²

(A) 1-d, 2-a, 3-b, 4-c

(B) 1-a, 2-d, 3-b, 4-c

(C) 1-c, 2-a, 3-b, 4-d

(D) 1-d, 2-b, 3-a, 4-c

Q 45 Select the air pollutant that does NOT belong to the category of secondary air pollutants.

(A) PAN (peroxyacetyl nitrate)

(B) Halogens

(C) Photochemical smog

(D) Ozone

Q 46 Read the given statements (S1, S2) pertaining to structural plywood as per IS: 10701-2012 and select the most appropriate option with respect to the correctness of the statements.

S_1: The moisture content of finished plywood boards shall be in the range of 5% to 15%

S_2: The tensile strength and compressive strength across the grain shall be greater than that along the grain.

(A) Both S_1 and S_2 are false

(B) S_1 is false and S_2, is true

(C) S_1 is true and S_2 is false

(D) Both S_1 and S_2, are true

Q 47 Identify the correct statements from the following based on IS specifications (IS:1130 1969) regarding the marble slabs and blocks supplied.

1. Marble slabs shall be supplied with a minimum thickness of 20 mm.

2. Marble blocks shall be supplied with a maximum thickness of 100 cm.

3. Marble blocks shall be supplied with a minimum length of 100 cm.

(A) Only 1 and 3   (B) Only 2 and 3

(C) Only 1 and 2   (D) 1, 2 and 3

Q 48 Study the given statements (S1, S2) about centrifugal pumps and select the most appropriate option with respect to the correctness of the statements.

S_1 : The operation of pumps connected in series (more than one impeller in the same shaft) increase the flow rate.

S_2 : The operation pumps connected in parallel allow the head to increase.

(A) S_1 is false and S_2 is true

(B) S_1 is true and S_2 is false

(C) Both S_1 and S_2 are false

(D) Both S_1 and S_2 are true

Q 49 Identify the correctly matched pair(s) from the following based on the unit of measurement used for the estimation of different items of work.

1. Stone slab in roof: square metres

2. Cutting of trees: tonnes

3. Lime concrete in foundation: cubic metres

(A) Only 1 and 2

(B) Only 1 and 3

(C) 1, 2 and 3

(D) Only 2 and 3

Q 50 Determine the volume of coarse aggregate (in m³ units), volume of fine aggregate (in m³ units) and cement (in kg units), respectively, for preparing 1 m³ of 1:2:4 (by volume) of concrete. (Assume 1 m³ of freshly mixed concrete corresponds to 1.54 m³ dry volume of concrete. Take 1 m³ of cement is equal to 1500 kg by weight.)

(A) 0.96 m³; 0.48 m³; 247.5 kg

(B) 0.88 m³; 0.61 m³; 330 kg

(C) 0.44 m³; 0.88 m³; 165 kg

(D) 0.88 m³; 0.44 m³; 330 kg

Q 51 A residential building fetches a monthly gross rent of Rs.12,000. The annual outgoings in the form of taxes and other contingencies is Rs. 12,000. The cost of land comes to Rs. 6,00,000. Estimate the total value of property (in Rs.) on a yearly basis. Assume the rate of interest as 6% per annum.

(A) 22,00,380

(B) 29,88,000

(C) 7,32,550

(D) 28,00,000

Q 52 Match the items under List I (Type of canals) with those under List II (Details pertaining to different types of canals).

List-I	List-II
P. Ridge Canal	1. Aligned roughly at right angles to the contour of area, neither on a watershed nor valley, does not intercept any cross drainage.
Q. Contour canal	2. Draw supplies from a river when there is high stage in river, not provided with head works for diversion of river water to canal.
R. Side slope canal	3. Aligned along a watershed, can command areas on both banks of canal.
S. Inundation canal	4. Aligned nearly parallel to the contours of the area, irrigation is possible on one side of the canal only.

(A) P-1, Q-3, R-4, S-2

(B) P-3, Q-4, R-1, S-2

(C) P-2, Q-4, R-3, S-1

(D) P-3, Q-1, R-2, S-4

Q 53 It is found that the weight of liquid is 15N which measures 6 litres. Calculate its specific weight.

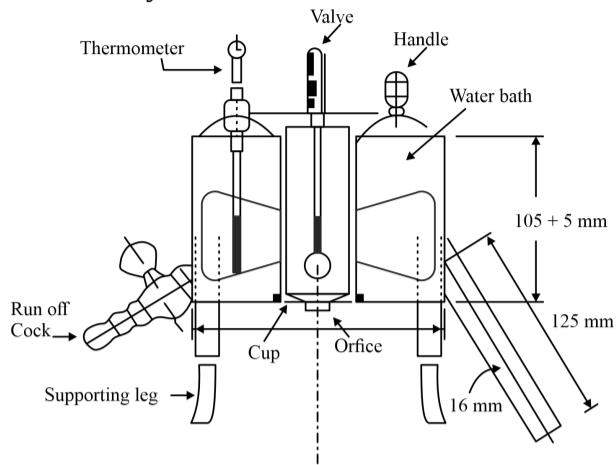(A) 2500 N/m³   (B) 4000 N/m³

(C) 3200 N/m³   (D) 1500 N/m³

Q 54 A solution of resin or resinous substance dissolved in alcohol, turpentine or spirit is called
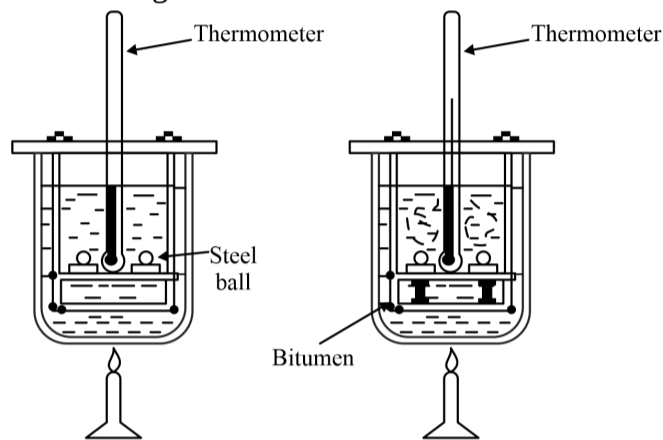
(A) aluminium paint

(B) distemper

(C) varnish

(D) resin paint

Q 55 Identify the correct pairs from the following with respect to the tests used to find the desirable properties of bitumen.
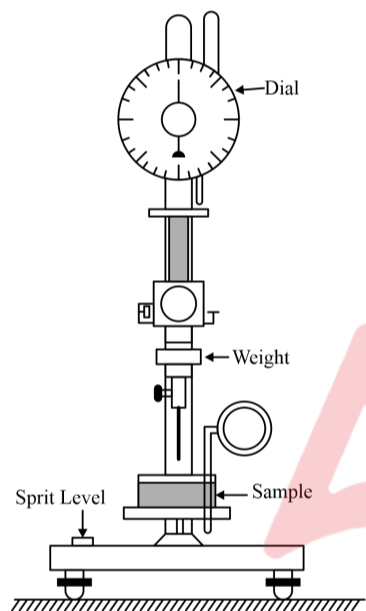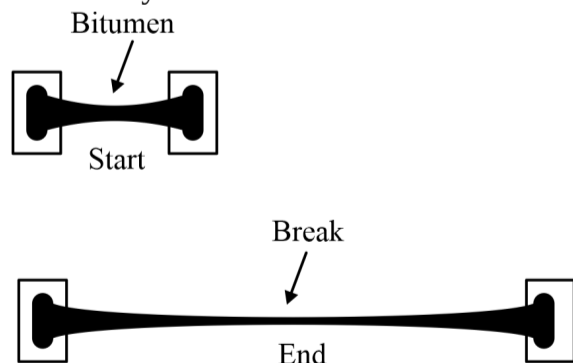
1. ViscosityTest

2. Softening PointTest

3. PenetrationTest

4. Ductility test

(A) Only 1, 2 and 4

(B) Only 2, 3 and 4

(C) Only 1, 3 and 4

(D) All of 1, 2, 3 and 4

Q 56 In saturated soils, the initial consolidation is mainly due to

(A) Expulsion of air in voids

(B) Compression of solid particles

(C) Compression of air in voids

(D) Compression of water molecules

Q 57 Identify Dicken's formula used for the estimation of the peak rate of runoff Q_P (in cumec units), during a flood from a catchment area of A (in km^2 units). (C_D - Dicken's constant)

(A) $Q_P = C_D A^{2/3}$

(B) $Q_P = C_D A^{3/4}$

(C) $Q_P = C_D A^{1/2}$

(D) $Q_P = C_D A^{3/5}$

Q 58 A crop having a base period of 120 days requires the following depth of water application in the planting stage, vegetation stage, flowering stage, and maturity stage 20cm, 32 cm, 25 cm, and 13 cm, respectively. Estimate the duty of irrigation water in ha/ cumec units.

(A) 848

(B) 648

(C) 1152

(D) 1346

Q 59 Which of the following is a vehicle used in making paint?

(A) Linseed oil

(B) Aluminium powder

(C) Antimony white

(D) Zinc white

Q 60 A simple circular curve of radius 600 m is to be set out on field. Calculate the value of versed sine for the curve if the deflection angle = 120°

(A) 120 m

(B) 300 m

(C) 453.33 m

(D) 333.33 m

Q 61 Which of the following stones is classified as igneous rock?

(A) Syenite

(B) Marble

(C) Limestone

(D) Kankar

Q 62 Study the following pairs (P, Q, R, S) with respect to GPS receivers used in GPS surveys and select the correct answer based on the matching.

P: GPS receivers : L-band radio processor

Q: Self-contained GPS receivers : Also known as 'GPS mice'

R: Dual-frequency receivers: Survey grade GPS, position accuracy according to differential correction with sub-centimeter

S: Carrier phase receivers: GPS receivers with 10 to 30 cm position accuracy with differential correction

(A) Q, R only

(B) P, R, S only

(C) P, Q only

(D) P, S only

Q 63 The actual length of a prismatic compression member is found to be 3 m. Calculate its effective length if one of its ends is restrained against both translation and rotation and the other end is restrained against rotation but free to translate.

(A) 2.8 m

(B) 3.6 m

(C) 6 m

(D) 3.2 m

Q 64 Match the following with respect to IS specifications on drinking water quality as per IS 10500-2012.

CHARACTERISTICS	ACCEPTABLE LIMIT
1. Calcium	a. 250 mg/l
2. Chloride	b. 75 mg/l
3. Fluoride	c. 0.2 mg/l
4. Free residual	d.1.0 mg/l

(A) 1-d, 2-a, 3-b, 4-c

(B) 1-b, 2-a, 3-d, 4-c

(C) 1-a, 2-b, 3-d, 4-c

(D) 1-b, 2-d, 3-a, 4-c

Q 65 Calculate the annual depreciation of a property, whose original cost is Rs. 30,00,000. Consider its scrape value as Rs. 3,00,000 after 30 years. Use the straight-line method.

(A) Rs.90,000   (B) Rs.87,000

(C) Rs.82,000   (D) Rs.93,000

Q 66 In case of volume batching followed for the manufacture of cement concrete, generally, the volume of one bag of cement is considered as

(A) 50 litres   (B) 25 litres

(C) 35 litres   (D) 42 litres

Q 67 In plane table surveying, Lehmann's rule are associated with:

(A) Solution of all type of resection problems

(B) Method of resection after orientation by compass

(C) Method of resection by two-point problem

(D) Method of resection by three-point problem

Q 68 French polish is a type of —————, which is used to hide the grain defects on hardwood substances.

(A) Flat varnish   (B) Water varnish

(C) Spirit Varnish   (D) Asphalt varnish

Q 69 Study the given statements (S_1, and $S_{2)}$ pertaining to the permeability of soils and select the most appropriate option with respect to the correctness of the statements.

S_1: Coefficient of permeability of a soil is directly proportional to the square of the particle size.

S_2: Permeability of a partially saturated soil is greater than that of a fully saturated soil.

(A) S_1 is true and S_2, is false

(B) S_1 is false and S_2, is true

(C) Both S_1 and S_2 are true

(D) Both S_1 and S_2 are false

Q 70 Match the items under List 1 (Members used for) with those under List 2 (Name of member).

List-1	List-2
P. Member supporting roof in a building	1. Tie
Q. Tensi on member in a roof truss	2. Boom
R. Compression member in a roof truss	3. Strut
S. Compression member in a crane	4. joist

(A) P-4, Q-1, R-3, S-2

(B) P-4, Q-2, R-1, S-3

(C) P-1, Q-2, R-3, S-4

(D) P-1, Q-4, R-2, S-3

Q 71 If the amount of annuity begins at some future date after a number of years, it is known as

(A) Annuity certain

(B) Annuity due

(C) Deferred annuity

(D) Perpetual annuity

Q 72 Match the items under List 1 (Components of turn out in a railway track) with those under List 2 (Details of components).

List-1	List-2
P. Stock rail	1. Tapered movable rail, at its thicker end it is attached to a running rail. Also known as switch rail.
Q. Crossing	2. Pair of tongue and stock rails with necessary connections and fittings
R. Tongue rail	3. Device introduced at the junction where two rails cross each other to permit the wheel flange of a railway vehicle to pass from one track to another.
S. Switch	4. Running rail against which a tongue rail operates

(A) P-1, Q-3, R-4, S-2

(B) P-1, Q-2, R-4, S-3

(C) P-4, Q-3, R-1, S-2

(D) P-4, Q-2, R-1, S-3

Q 73 The unit of measurement used for estimating the quantity of expansion joint is

(A) cubic metres   (B) square metres

(C) quintal   (D) running metre

Q 74 Which of the following is NOT the effect of noise?

(A) Fluorosis   (B) High blood pressure

(C) Hearing loss   (D) Sleeplessness

Q 75 Textural classification of soil is based on:

(A) Grain size and consistency limits

(B) Consistency limits only

(C) Grain size only

(D) Plasticity index

Q 76 Identify the behaviour study of soils in which the zero air void unit weight is found.

(A) Compaction test

(B) Shear strength test

(C) Permeability test

(D) Consolidation test

Q 77 Select the INCORRECT statement pertaining to the lining of an irrigation canal.

(A) Lining helps to provide a flatter hydraulic gradient to canal, and better command area.

(B) Lining minimizes the seepage loss in the canal, more area can be irrigated.

(C) Lining increases the discharge in the canal section by increasing the velocity.

(D) Due to lining the resistance to flow increases and the velocity of flow decreases.

Q 78 The minimum length of a tongue rail in case of a broad-gauge railway track is…………….

(A) 4.34 m   (B) 3.44 m

(C) 3.66 m   (D) 4.22 m

Q 79 The ratio of Young's modulus of elasticity of two materials (E_1 to E_2) is 2.5. Find the ratio of the elongations in the two bars ($\delta l_1 \text{ to } \delta l_2$) of these

materials if they are of the same length and same area and subjected to the same force P.

(A) 1   (B) 2.5

(C) 2   (D) 0.4

Q 80 Calculate the Reynolds number if the kinematic viscosity of water is 0.01×10^{-4} m^2/s, which is flowing through a pipe of diameter 200 mm with the velocity of 5 m/s.

(A) 1×10^6 (B) 2.2×10^6

(C) 1.6×10^6 (D) 0.5×10^6

Q 81 Consider the following statements with respect to proportioning of flanges in a plate girder and identify the correct option.

Statement A: When the moment-resisting capacity of a plate girder is to be increased, the flange cover plates may be provided over the flange angles.

Statement B: The flange plates shall be thicker than the flange angles in a riveted/bolted plate girder.

(A) Statement A is correct, but statement B is incorrect.

(B) Both the statements are correct.

(C) Both the statements are incorrect.

(D) Statement B is correct, but statement A is incorrect.

Q 82 An overhanging beam CADEBF is shown in the figure below. Calculate the sum of the bending moment values at A and B. Ignore the sign conventions.
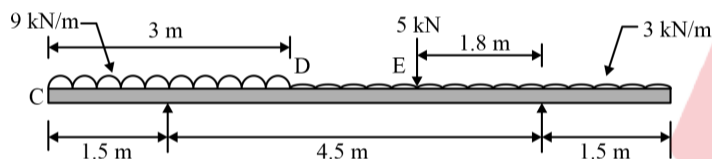
(A) 16.78 kN-m   (B) 13.50 kN-m

(C) 10.00 kN-m   (D) 12.50 kN-m

Q 83 The following statements (P, Q) are derived on the basis of precipitation values from the mass curve of rainfall of a self- recording rain gauge, given in the table. Identify the correct statement(s) and select the most appropriate option.

Time from start of rainfall (minutes)	0	15	30	45	60	75	90
Cumulative rainfall (mm)	0	6	15	15	30	35	45

P. The intensity of rainfall during the time interval (0 to 15) is more than the intensity of rainfall during the time interval (60 to 75).

Q. There is no rainfall during the time interval (30 to 45).

(A) Neither P nor Q

(B) P only

(C) Both P and Q

(D) Q only

Q 84 Identify the defect in timber, which is NOT caused by seasoning of timber.

(A) Checks   (B) Rindgall

(C) Warpage   (D) Splitting

Q 85 Match the following with respect to types of precipitation.

List-I		List-II
1	Sheet	a	It is ice coating formation when rain or drizzle comes in contact with cold object on the ground.
2	Glaze	b	It is showery precipitation in the form of irregular pellets or lumps of ice of size more than 8 mm.
3	Hail	c	They are frozen raindrops of transparent grains that are formed when rain falls through the air at a sub-freezing temperature.

(A) 1-c, 2-a, 3-b   (B) 1-b, 2-a, 3-c

(C) 1-c, 2-b, 3-a   (D) 1-a, 2-c, 3-b

Q 86 Select the option that is true regarding the following two statements labeled Assertion (A) and Reason (R).

(A) For horizontal curves, the centrifugal ratio increases along the length of the transition curve.

(R) In a horizontal curve, the superelevation is provided at an increasing rate with zero at the start to the maximum value at the end of transition curve.

(A) Both A and R are true and R is the correct explanation of A

(B) Both A and R are true, but R is not the correct explanation of A

(C) A is false, but R is true

(D) A is true, but R is false

Q 87 Select the option that is correct regarding the following two statements, labelled as Assertion (A) and Reason (R).

Assertion (A): Copper sulphate should be used for control of aquatic weeds, except for the algae.

Reason (R): The concentration of copper sulphate required to destroy the vegetation will assuredly kill any fish present in water.

(A) A is false, but R is true

(B) Both A and R are true, but R is not the correct explanation of A.

(C) A is true but R is false

(D) Both A and R are true and R is the correct explanation of A.

Q 88 Consider the below statements with respect to surveying and identifying the correct answer.

Statement A: Latitude of a survey line is defined as its coordinate length measured in the direction perpendicular to an assumed meridian direction.

Statement B: The type of levelling in which levels are taken on each side of a main line at right angles to that line in order to determine a vertical cross-section of the surface of the ground is called Differential levelling.

(A) Statement B is correct, and statement A is incorrect.

(B) Both statements are correct.

(C) Statement A is correct, and statement B is incorrect.

(D) Both statements are incorrect.

Q 89 An offset is laid out 5° from its true direction on the field. If the scale of plotting is 20 m to 1 cm, find the maximum length of the offset so that the displacement of the point on the paper may not exceed 0.5 mm.

(A) 5 m   (B) 9.22 m

(C) 11.47 m   (D) 13.33 m

Q 90 Which of the following minor losses in pipe flow is taken as $\frac{V^2}{2g}$?

(Consider that 'V' is velocity of the liquid in the pipe and 'g' is acceleration due to gravity.)

(A) Loss of head at the entrance of the pipe with a sharp-cornered entrance

(B) Loss of head at the exit of the pipe

(C) Loss of head due to friction

(D) Loss of head due to obstruction in the pipe

Q 91 As specified in IS 2386 (Part IV): 1963, which of the following set of sieves are used to find the crushing value of coarse aggregates?

(A) 6.3 mm, 10 mm, 12.5 mm

(B) 10 mm, 12.5 mm, 20 mm

(C) 2.36 mm, 10 mm, 12.5 mm

(D) 2.36 mm, 6.3 mm, 12.5 mm

Q 92 As per IS456:2000, the deflection, including effects of temperature, creep and shrinkage occurring after erection of partitions and application of finishes of RC structures, should not normally exceed -

(A) span/250 or 20 mm, whichever is less

(B) span/350 or 20 mm, whichever is less

(C) span/200 or 40 mm, whichever is less

(D) span/350 or 40 mm, whichever is less

Q 93 A hydraulic press has a ram of crosssection area 30×30 cm and a plunger of cross section area 4 x 4 cm as shown in figure. Find the force 'F' required to lift the weight 'W' = 30 kN.
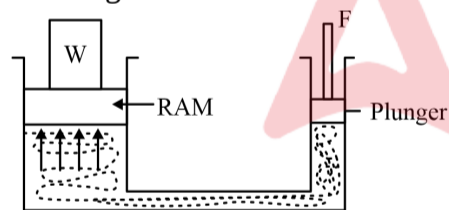
(A) 589.58 N   (B) 533.33 N

(C) 481.22 N   (D) 232.88 N

Q 94 Consider the following statements P and Q, based on the testing of natural building stones, following the IS codes and select the correct option.

P. The shear strength of the test piece of natural building stone tested using Johnson shear tool is estimated as, $S = \frac{W}{2A}$ .where, W is the total maximum load indicated by testing machine and A is the centre cross-section area of test piece.

Q. For testing the durability of stone as per IS 1126-1974, the durability value of the stone shall be expressed in percent-age as change in the volume of specimen.

Q 95 A hydraulic jump is categorised as an oscillating jump when the Froude number of the incoming flow lies between

(A) 1.7 and 2.5   (B) 0.5 and 1.2

(C) 2.5 and 4.5   (D) 1.2 and 1.7

Q 96 For a steady, ideal flow of an incompressible fluid, the total energy at any point of the fluid is constant. This is called

(A) Bernoulli's equation

(B) The moment of the momentum equation

(C) Euler's equation

(D) The momentum equation

Q 97 Calculate the combined correction, due to refraction and Earth's curvature, in levelling (surveying) for a distance of 2500 m.

(A) 0.070 m   (B) 0.420 m

(C) 0.490 m   (D) 0.168 m

Q 98 In case of slenderness limits, according to IS 456-2000, the ratio of unsupported length (l) to the least lateral dimension (d) of a column should not exceed a value of……………?

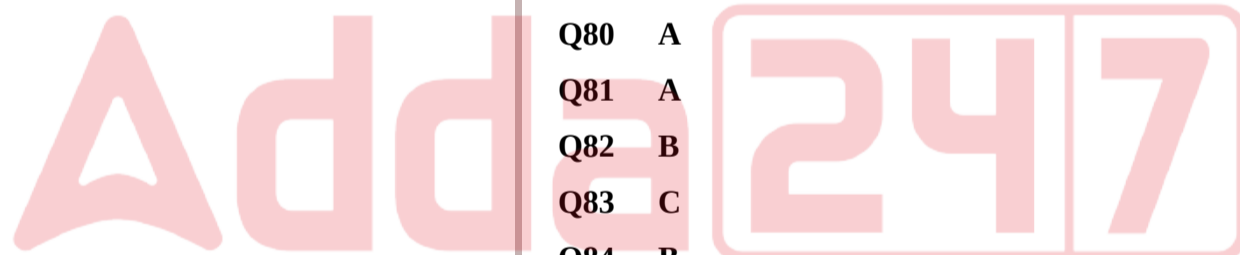(A) 40   (B) 60

(C) 30   (D) 75

Q 99 The maximum water content at which reduction in the water content will NOT cause a decrease in the volume of soil mass is known as …………………….of soil sample

(A) liquid limit   (B) liquidity index

(C) shrinkage limit   (D) plastic limit

Q 100 Consider the following statements with respect to effects of air pollutants on human health and identify the INCORRECT statement.

(A) Inhalation of carbon monoxide leads to reduction in the amount of oxygen delivered to organs and tissues.

(B) Sulphur dioxide can cause cancer and mutations and it is radioactive in nature.

(C) Inhalation of lead can cause mental retardation and behavioural disorders.

(D) Nitrogen dioxide irritates the lungs and can cause bronchitis and pneumonia.

Answer Key

Q1	A		Q51	D
Q2	C		Q52	B
Q3	D		Q53	A
Q4	C		Q54	C
Q5	C		Q55	D
Q6	B		Q56	B
Q7	B		Q57	B
Q8	B		Q58	C
Q9	B		Q59	A
Q10	D		Q60	B
Q11	C		Q61	A
Q12	B		Q62	B
Q13	B		Q63	B
Q14	A		Q64	B
Q15	A		Q65	A
Q16	C		Q66	C
Q17	A		Q67	D
Q18	B		Q68	C
Q19	C		Q69	A
Q20	C		Q70	A
Q21	A		Q71	C
Q22	D		Q72	C
Q23	C		Q73	D
Q24	A		Q74	A
Q25	D		Q75	C
Q26	D		Q76	A
Q27	B		Q77	D
Q28	C		Q78	C
Q29	B		Q79	D
Q30	A		Q80	A
Q31	A		Q81	A
Q32	D		Q82	B
Q33	B		Q83	C
Q34	A		Q84	B
Q35	C		Q85	A
Q36	D		Q86	A
Q37	D		Q87	D
Q38	D		Q88	D
Q39	C		Q89	C
Q40	C		Q90	B
Q41	C		Q91	C
Q42	D		Q92	B
Q43	C		Q93	B
Q44	A		Q94	(C)
Q45	B		Q95	C
Q46	C		Q96	A
Q47	C		Q97	B
Q48	C		Q98	B
Q49	B		Q99	C
Q50	D		Q100	B

Hints & Solutions

Q 1 Text Solution:

Cutback bitumen:

(i) Cutback bitumen is bitumen with less viscosity which, is achieved by the addition of volatile diluent. Hence, to increase the fluidity of the bitumen binder at low temperatures the binder is blended with a volatile solvent.

(ii) The viscosity of the cutback bitumen and the rate at which hardness on the road depends on the characteristics and quantity of both bitumen and volatile oil used as diluent.

(iii) Cutback bitumen is available in three types:

• **Rapid curing (RC):**- In this bitumen is fluxed with Naptha/gasoline, petroleum

• **Medium curing (MC):**- In this bitumen is fluxed with Kerosene or high diesel oil

• **Slow Curing (SC):** - In this bitumen is fluxed with High boiling point gas oil or light oils

(iv) Cutback bitumen is prepared by diluting a paving grade bitumen with a volatile solvent such as light fuel oil or kerosene.
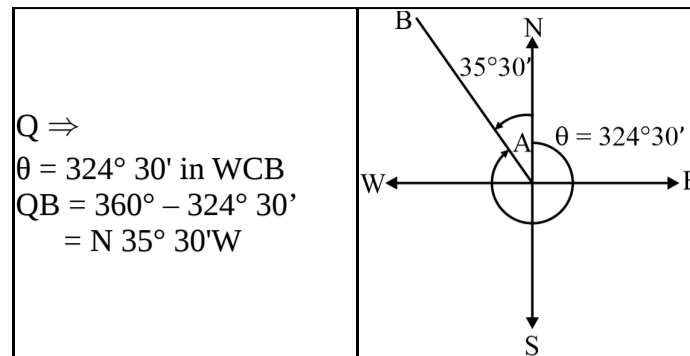
Q 2 Text Solution:

Permeability

• Permeability refers to the ability of soil to allow the flow of water through it.

• When soil is compacted, the void spaces between soil particles are reduced.

• These void spaces are crucial for the movement of water through the soil.

• As dry density increases through compaction, the soil particles come closer together, reducing the size of the void spaces.

• This reduction in void spaces makes it more difficult for water to flow through the soil, resulting in a decrease in permeability.

Q 3 Text Solution:

P $\Rightarrow$ θ = 144°30' in W.C.B. QB = 180°–144°30' = S35°30'E	(diagram: N, W, E, S axes; A at center; θ = 144°30′; line to B at 35°30′)
Q $\Rightarrow$ θ = 215°30' in WCB QB = 215°30' – 180° = S35°30'W	(diagram: N, W, E, S axes; A at center; θ = 215°30′; line to B at 35°30′)
R $\Rightarrow$ θ = 125° 30' in WCB QB = 180° – 125° 30' = S54° 30'E	(diagram: N, W, E, S axes; A at center; θ = 125°30′; line to B at 54°30′)

|	
Q $\Rightarrow$ θ = 324° 30' in WCB QB = 360° – 324° 30' = N 35° 30'W	(diagram: N, W, E, S axes; A at center; θ = 324°30′; line to B at 35°30′)

Q 4 Text Solution:

Hirakud is the longest earthen dam in the world; it is built on the river Mahanadi in Odisha. It was the first major multipurpose river valley project since India's Independence.

Some Facts about Dam

1. Idukki Dam- Arch Dam

2. Most of gravity Dam constructed in India are straight solid gravity dams. ex-Bhakra Dams.

3. Bhakra Dam (A concrete Dam) & Rana Pratap Sagar Dam (A stone Masonry Dam) are rigid dam in India.

4. Best/Most economical Central Angle in an arch Dam is the one whose value is equal to 133° 34' at mid-height in constant radius dam.

5. A check Dam is a soil conservation structure.

6. The Tehri dam is highest dam in India. It is a multi-purpose rock & earth-fill embankment dam on the Bhagirathi River near Tehri (UK).

Q 5 Text Solution:

(diagram: two rooms 4 × 6 and 6 × 6, 6 m height, 10.60 m width)
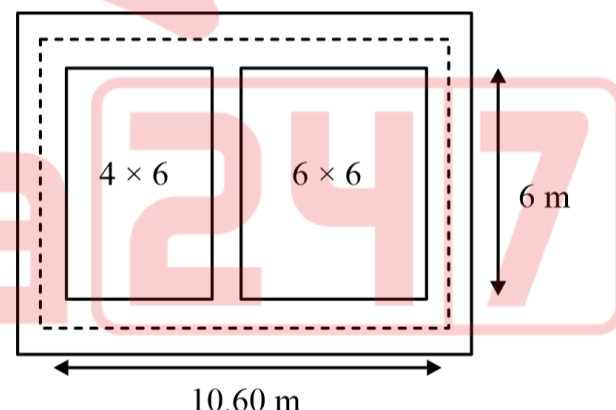
Total length of the wall–

(i) Center to center distance of long wall

$$= \left(\frac{0.30}{2} + 4.0 + 0.30 + 6.0 + \frac{0.30}{2} \right) \times 2$$

= 10.60 ×2

= 21.20 m

(ii) Center to center distance of short wall= 6.0 × 3 = 18 m

Total length = 21.20 + 18.0 = 39.20 m

Volume of PCC = L × B × H

= 39.20 × 1.1 × 0.30

= 12.936 m³

Q 6 Text Solution:

Given,

Gross bearing capacity (q_g) = 420 kN/m²

Unit weight of soil = 20 kN/m³

Depth of footing = 1.2 m

So,

Net bearing capacity

$q_n = q_g - \gamma_{Df} = 420 - 20 \times 1.2$

$= 396$ kN/m^2

Q 7   Text Solution:

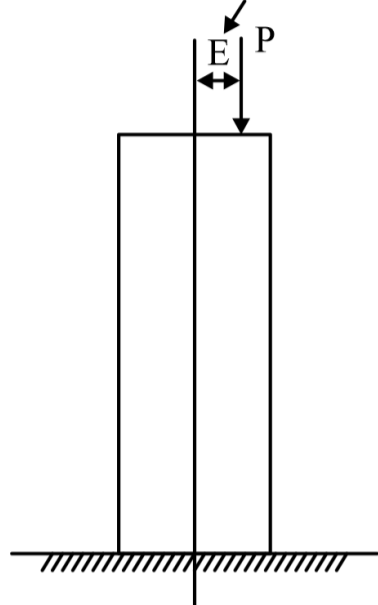Bending stress(σ) is a result of the couple of Pxe about the y-axis only, as a load P at the centroid causes direct compressive stress.

Using Flexure formula

$$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$$
$$\sigma = \frac{M}{z} = \frac{6M}{bd^2}$$

Eccentricity

Eccentricity loaded column

Then bending stress $= \frac{6M}{bd^2} = \frac{6 \times P \times e}{bd^2}$
$$\sigma = \frac{6\,Pe}{bd^2}$$

Q 8   Text Solution:

Road Classification	Minimum & steep Terrain (m)
NH and SH	6.25
Major District Roads	4.75
Other District Roads	4.75
Village Roads	4.0

Q 9   Text Solution:

According to IS 456:2000, the pH value of water used for mixing & curing of cement concrete shall not be less than 6. As the pH below 6 can be acidic & react with the cement to form deleterious compounds, which can reduce the strength & durability of the concrete.

Q 10   Text Solution:

Given,

Volume of specimen = 50 × 50 × 150

$= 375000$ mm^3= 375 cm^3

Weight of specimen = 250 gm

Percentage moisture content = 15%

So the actual weight of timber =

$(1 - 0.15) \times 250 = 212.5\,gm$

Density of timber $= \frac{212.5}{375} = 0.567\,gm/cc$

Specific gravity $= \frac{\text{Density of substance}}{\text{Density of water}} = \frac{0.567}{1}$

Special gravity = 0.567

Q 11   Text Solution:

Sound waves

- The sound is defined as a vibration that propagates as an audible wave of pressure, through a medium such as a gas, liquid or solid.

- The disruption pattern that results from energy moving away from the sound source is called a sound wave. Sound waves are longitudinal waves.
- **Sound propagation from one point to another point is governed by Mechanical wave's formula.**
- This indicates that the direction of energy wave propagation and particle vibration propagation are parallel.
- The atoms vibrate back and forth when they are in this state.
- There are high-pressure and low-pressure regions in the medium as a result of this constant back and forth action. These areas of high and low pressure are referred to as rarefactions and compressions, respectively.

Sabine's formula

- According to Sabine's formula, the reverberation time is used to find out the sound quality in an auditorium, concert hall, or other places.
- Reverberation time is the time that is required by the sound to decay or fade away in an enclosed area after stopping the source of the sound.

Q 12   Text Solution:

Asbestos is a natural mineral, which consists of silicate of calcium and magnesium found in the form of very thin fibers.

Asbestos finds wide acceptance in construction due to the following properties:

- **Fire Resistance**- The products derived from asbestos are conducive for use in high-heat settings as they can successfully withstand high temperatures. Therefore, when asbestos is heated at or above 550°C, asbestos does not lose its elasticity and strength and does not become brittle at all.
- **Durability**- Asbestos products are exceptionally strong and durable, therefore making them a perfect choice in the construction industry.
- **Friction Resistance**- Automotive assemblers found asbestos resisted friction and wear. In the automobile industry, Asbestos is employed in the manufacture of brakes, clutches, and gaskets.
- **Lightweight**- Asbestos products are also sought-after, considering their light weight. This property makes asbestos products the perfect choice in the airplane industry.
- **Less Cost**- Asbestos is relatively cheap to extract from its natural sources. The process of blending it with other materials to form Asbestos products is also a cheap process.

- **Sound Absorption**- Asbestos products also have the property of sound absorption.

Q 13 Text Solution:

The hydraulic machines which convert the mechanical energy into hydraulic energy are called pumps.

Centrifugal pumps	Reciprocating pumps
The discharge is continuous and smooth	The discharge is fluctuating and pulsating
It can handle a large quantity (Discharge) of liquid	It handles a small quantity (Discharge) of liquid only
It can be used for lifting highly viscous liquids	It is used only for lifting pure or less viscous liquids like lifting oils from deep wells
It is used for large discharge through smaller heads	It is meant for a small discharge and high heads
Cost of a centrifugal pump is less as compared to reciprocating pump	approximately four times the cost of a centrifugal pump
Centrifugal pump runs at high speed. They can be coupled to an electric motor	It runs at low speed. Speed is limited due to consideration of separation and cavitation.
The operation of a centrifugal pump is smooth and without much noise.	The operation of a reciprocating pump is complicated and with much noise.
The maintenance cost is low	The maintenance cost is high.
Efficiency is low	Efficiency is high

Q 14 Text Solution:

Unconfined compression test apparatus:

- The unconfined compression test apparatus is used to determine the compressive strength of a soil sample without applying any lateral confinement.
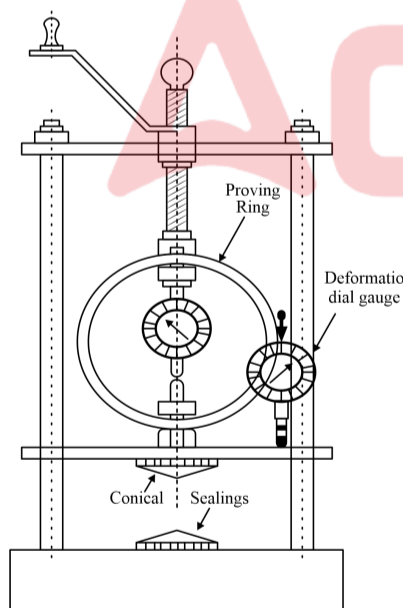
- The apparatus typically consists of a loading device, loading platen, base plate, sample holder or mold, and a displacement measurement device.
- The soil sample is prepared in a cylindrical shape and is subjected to axial load until failure.

Q 15 Text Solution:

Given,

Length, L = 8 m

Diameter (ϕ) = 20 mm = 20×10^{-3} m

Density of steel (ρ_s) = 7850 kg/m^3

Theoretical weight of steel bar

= Volume of steel bar × density of steel

$= \frac{\pi}{4}\phi^2 \times L \times \rho_s$

$= \frac{\pi}{4}\left(20 \times 10^{-3}\right) \times 8 \times 7850$

= 19.72 kg

Q 16 Text Solution:

- Side slope canal is aligned roughly at right angles to the contours, traversing the side slopes of the land.
- Contour canal follows the contours of the land, not at right angles to them.

Ridge Canal (Watershed canal)	Contour Canal (Single Bank Canal)	Side Slope Canal
Aligned along the ridge or natural watershed Line	Aligned along the natural contour of the country	Aligned perpendicular to the **contour** of the country.
A ridge canal does not drainage line and Hence cross drainage work is not required.	Maximum cross-drainage work is required	No Cross Drainage work is required.
Can irrigate on both sides of the ridge and hence, a large area can be cultivated	Can irrigate areas only on one side	Can irrigate areas only on one side. It is Neither on the watershed nor in the valley.
Ridge line are quite economical and can be provided in plane areas.	It is generally provided in Hilly areas.	This type of canal is Nearly parallel to the Natural drainage of the country.

Q 17 Text Solution:

Prismoidal formula (Simpon's rule is used):

- Valid for odd number of offset and number of division is even.

$$\text{Volume } (V) = \frac{L}{3}[(A_1 + A_n) + 4(\text{Even}) + 2(Odd)]$$

- For irregular boundaries, Simpson's rule is preferred over the trapezoidal rule to calculate the given area.
- In the case of an even number of crosssections,the end strip is treated separately and the area of the remaining strip is calculated by Simpson's rule. The area of the last strip may be calculated by trapezoidal formula.

Prismoidal correction:

The difference between the volume computed by the trapezoidal formula and the prismoidal formula is known as a prismoidal correction.

Since the trapezoidal formula always over estimates the volume. Prismoidal correction is always subtractive in nature.

$$C_P = \frac{D}{6}(d_2 - d_1)^2$$

Where,

D = Distance between the sections

S = H : 1V (Side slope)

d_1 and d_2 = depth of earth work at centre line

Q 18   Text Solution:

Storm water inlets: Stormwater inlets are the openings in the pavement, which collect surface runoff & direct it into the storm sewer system. These are used to prevent flooding & protect streets from damage.

Types of Manholes:

(a) Straight: Trough Manholes: When there is a change in the size of the sewer, the soffit or crown level of the two sewers should be the same.

(b) Drop Manholes: To connect the high-level branch sewer to the low-level main sewer by vertical dropping pipe.

(c) Junction Manholes: Built at every junction of two or more sewer

(d) Flushing Manhole: When it is not possible to obtain self-cleaning velocities due to the flatness of the gradient. It is essential that some form of flushing device be incorporated. Flushing manholes are located at the head of sewers or at points where the grade changes significantly. They are used to flush out sediment & debris, which may have accumulated in the sewer system.

Catch basin: It allows the storm water to enter the sewer by eliminating the silt, grit, etc. at the bottom of the basin. It helps to maintain the efficiency of the sewer system & prevent blockages.

Catch Basin
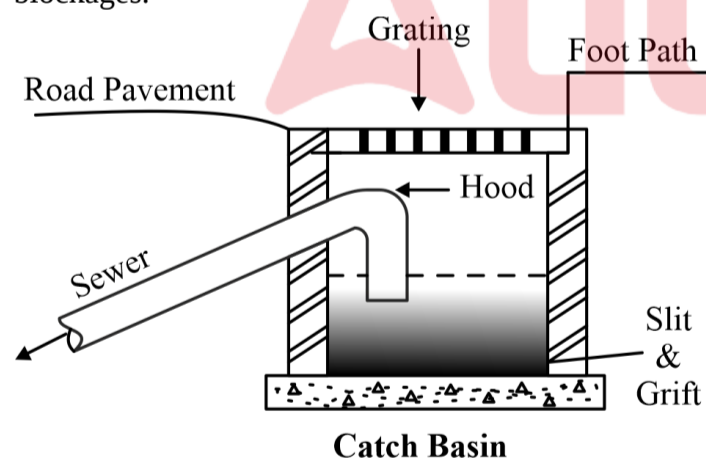
Q 19   Text Solution:

Quick setting cement: Fine grinded OPC with reduced Gypsum content & a small amount of aluminium sulphate.

- IST 5 minutes & FST = 30 minutes. It set quickly but not harden.
- It is used in under water concreting.

Sulphate-resistant cement has a C_3A content of 3 not more than 5%. C_3A reacts with sulphates present in the soil or water to form expansive compounds, leading to cracking & deterioration of concrete. By limiting the C3A content, the risk of sulphate attack is reduced.

Low heat Portland cement: Low C_3S & C_3A and 3 more contents of C_2S By reducing the C_2S content, the heat generation is minimized, resulting in a low heat cement.

- It is use in mass concrete work & widely use in retaining wall, abutment, dam.
- Rate of development of strength is low but ultimate strength is same

Q 20   Text Solution:
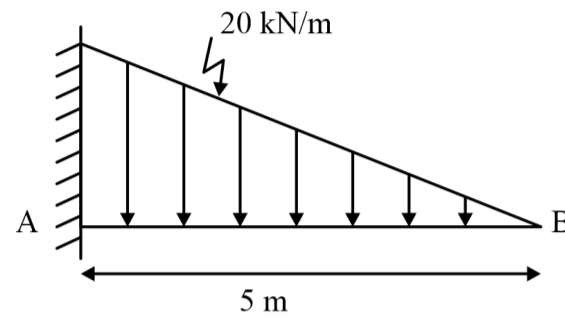
Slope at point B $\Rightarrow \frac{wl^3}{24\,EI}$

$= \frac{20 \times 5^3}{24 \times EI}$

$\theta_B = \frac{104.167}{EI}$

Q 21   Text Solution:

Factor of safety: The ratio of the ultimate strength of a material to working strength (or permissible stress).

(a) F.O.S. = $\frac{\text{Strength of material}}{\text{Permissible stress}}$

(b) F.O.S. = $\frac{\text{Yield stress}}{\text{Working stress}}$

- Factor of safety for concrete is taken as 1.5 while the Factor of safety for steel is taken as 1.15.
- Steel is manufactured in the factories under quality control. So, the factor of safety is taken less than that of concrete which is produced in the field in not that much controlled way.

Q 22   Text Solution:

As per IS: 3129-1985:

- Low-density particle board is manufactured by low-density wood or other lignocellulose by disintegration of the same or other predetermined sizes.
- The maximum thickness of low-density particle boards shall be 50 mm.
- The thickness of insulation particle boards in mm shall be as 50,45,40,35,30,27,25,22,19,16, and 12.
- The maximum thickness of insulation particle boards shall be 50 mm.
- The maximum length of the insulation particle board is 3650 mm.
- The maximum width of the insulation particle board is 1800 mm

Q 23   Text Solution:

Water Logging: Water logging occurs when the soil is saturated with water. The agricultural land becomes waterlogged when the soil pores within the root zone of the crops get saturated and the normal conditions circulation of air is cut off (aerobic conditions). Under

anaerobic conditions, the activity of these aerobic bacteria decreases. The water logging affects the productivity of the land and leads to a reduction in crop yield.

Effects of water logging:

1. Reduction in productivity
2. Growth of unwanted plants
3. Creation of cold and damp climate that causes spreading of diseases like dengue and malaria.
4. Difficulty in cultivation operation
5. Salinity and alkalinity of the soil are increased in the root zone.

Q 24 Text Solution:

Given,

Area of rectangle $(A_1) = 300 \times 200 = 60000$ mm^2

Area of circle $(A_2) = \frac{\pi}{4} \times 150^2 = 17662.5$ mm^2

Centroid of circle from (AB) $(y_2) = 300 - 100 = 200$ mm

Centroid of rectangular from (AB) $(y_1) =$

$\frac{300}{2} = 150$ mm

Centroid of composite member $= \frac{A_1 y_1 - A_2 y_2}{A_1 - A_2} = \frac{6000 \times 150 - 17662.5 \times 200}{6000 - 17662.5} = 129.14$ mm

Q 25 Text Solution:

Plasticity: The range of water content over which soils remain in a plastic state is known as the "Plasticity" of the soil. Clayey soils exhibit this plasticity property due to the presence of clay minerals.

Plasticity Index:

- It is a measure of the plasticity of the soil and is calculated as the difference between the liquid limit and the plastic limit.
- Plasticity index order: clay> silt> sand > gravel
- Adding silt to the clay reduces the plasticity or plasticity index of soil because the percentage of clay content decreases.

Plasticity index	Plasticity	Type of Soil
0	Non-plastic	Sand
<7	Low-plastic	Silt
7-17	Medium-plastic	Silt-clay
>17	High-plastic	Clay

Q 26 Text Solution:

- Rigid pavements are typically analyzed using elastic theory, not plastic theory. The assumption is that the pavement is resisting over an elastic foundation & stress analysis is based on this principle.
- Rigid pavements do not get deformed to the shape of the supporting layer below it. Rigid pavements are designed to be stiff & resist deformation, not like flexible pavements.
- Flexible pavements can experience both permanent (non-recoverable) & temporary

(recoverable) deformations due to the traffic loads & environmental factors. These deformations can manifest as cracks, rutting & other surface distresses.

Q 27 Text Solution:

In reality, the flow in a circular pipe is generally considered laminar at Reynolds numbers less than about 2000, not 4000. Above this range, the flow transitions to turbulent.

	Laminar	Transition	Turbulent
Flow in pipe	$R_e < 2000$	$2000 < R_e < 4000$	$R_e > 4000$
Flow between parallel plate	$R_e < 1000$	$1000 < R_e < 2000$	$R_e > 2000$
Flow in open channel	$R_e < 500$	$500 < R_e < 2000$	$R_e > 2000$
Flow through soil	$R_e < 1$	$1 < R_e < 2$	$R_e < 2$

Q 28 Text Solution:

Effect of water-cement ratio on concrete:

- The ratio of water-cement is generally between 0.35 to 0.65.
- Water cement ratio is inversely proportional to the strength of concrete. If the water-cement ratio increases then the strength decreases and vice versa. The W/C is directly related to workability because if the water-cement ratio increases then the concrete gets wetter and more consistent and can be placed easily.

Size of Aggregates:

- Finer aggregate requires more water because of the larger surface area, hence aggregate with finer particles needs more water to make it workable. On the other hand, bigger particles have less surface area, and therefore demand less water for wetting surfaces and require less amount of paste for lubricating. So bigger particles give higher workability for fixed water content.

The Shape of Aggregates:

- Irregular shape and rougher texture of angular aggregate require more water as compared with the round shaped aggregate.
- For fixed volume or weight, rounded particles has lesser surface area and lesser voids.
- Hence round shaped aggregates gives higher workability than angular, flaky or elongated aggregates.

Concrete Maturity:

- Concrete maturity reflects how far curing has progressed.
- Maturity is the relationship between concrete temperature, time, and strength gain.

Q 29 **Text Solution:**

Given,

Time (n) = 10 years

Scrap value = 10%

Sinking fund interest = 5%

Warehouse cost = 4,00,000

Scrap value = $400000 \times \frac{10}{100} = 40000$

Sinking fund value (s) = 4,00,000 – 40,000 = 3,60,000

Annual installment = $\frac{Si}{(1+i)^n - 1} = \frac{360000 \times 0.05}{(1+0.05)^{10} - 1}$

= 28621.64 Rs

Q 30 **Text Solution:**

Area of reinforcement $\left(A_{s\phi}\right) = \frac{\pi}{4} \times d^2$

$= \frac{\pi}{4} \times 8^2 = 50.265 \text{ mm}^2$

Area of reinforcement given shorter span (A_{st}) = 200 mm^2/m

Spacing of reinforcement (S) = $\frac{1000 \times A_{s\phi}}{A_{st}}$

$= \frac{1000 \times 50.265}{200} = 251.32 \text{ mm}$

Q 31 **Text Solution:**

Given,

Width of beam = 200 mm,

Effective depth = 400 mm

For Fe-415,

Limiting moment of resistance = 0.138 f_{ck} bd^2

= 0.138 × 20 × 200 × 400^2

= 88.30 kN-m

Q 32 **Text Solution:**
LACINGS:

- Lacing is a system of connecting elements in built up column.
- Lacing make the component of column act as a single unit.
- If the component of column are each very close to each other, then tack rivets are used to make them act as a single unit.
- If the spacing of component is more then the rivets are useless and so we use lacing or batten.

The lacing is of two types.
(i) Single lacing
(ii) Double lacing

Single Lacing   Double Lacing
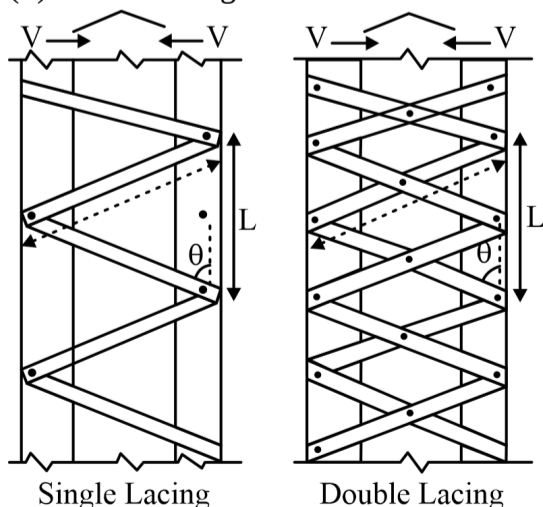
Q 33 **Text Solution:**

The approximate amount of entrapped air to be expected in normal (non-air-entrained) concrete is given by the table of IS 10262: 2019

S.No.	Nominal Maximum size of Aggregate (mm)	Entrapped Air, as Percentage of the Volume of Concrete
1	10	1.5
2	20	1.0
3	40	0.8

Q 34 **Text Solution:**

Include angle = Fore bearing of next line - Backbearing of previous

The sum of Include angle in the clockwise direction (i.e, excluded angle) = (2n+4)90° = (2x5+4)x90° = 1260°

Angle	Fore bearing	Back bearing	Included angle	Final included angle
A	80°10'	130°15'	- 50°5' (+360°)	309°55'
B	120°20'	259°0'	-138°40' (+360°)	221°20'
C	170°50'	301°50'	131° (+360°)	229°
D	230°10'	350°50'	120°50' (+360°)	239°20'
E	310°20'	49°30'	260°50'	260°50'

Total sum of final included angle = 1260°25'

So, error = 1260°25' - 1260° = 25'

Correction = - 25'

So correct included angle D = 239°20' - $\frac{25'}{5}$ = 239°15'

Fore bearing of line DE = Included angle D + back bearing of CD

Fore bearing of line DE= 239°15'+ 350°50' = 590°05'-360° = 230° 5'

Q 35 **Text Solution:**

The ϕ-index represents an infiltration rate where the infiltration rate surpasses the threshold at which the volume of runoff equals the volume of rainfall.
Calculation:
if Rainfall < φ index; Runoff = 0
if Rainfall ≥ φ index; Runoff = Rainfall - φ index
The total direct runoff from the catchment = 0 + (6 – 3) + (9 – 3) + (5 – 3) + (3 – 3) = 11 cm

Q 36 **Text Solution:**
Soil Classification:

- Sand is said to be well-graded if the uniformity coefficient (C_u) is greater than 6 and the coefficient of curvature (C_C) lies in between 1 to 3
- Gravel is said to be well-graded if the uniformity coefficient (C_u) is greater than 4 and the coefficient of curvature (C_C) lies in between 1 to 3.

Calculation:
In this case, our soil is sand and it is given as C_u > 6, and C_c lies in between 1 and 3 so it is well graded sand or SW.

Q 37 **Text Solution:**
There are different types of estimate

Approximate or preliminary estimate: The approximate estimate serves as the preliminary evaluation of various project aspects, aiding in financial decision-making and administrative approval. For revenue-generating projects, probable income is included, while noncommercial projects are assessed based on necessity, utility, prospects, and financial availability.

Different methods of approximate estimate are given below.

a. Plinth area method: The construction cost is calculated by multiplying the plinth area with the plinth area rate, where the area is derived from the multiplication of the length and breadth (outer dimensions of the building).

b. Cubical content method: This method, commonly applied to multistoried buildings, is more accurate than the plinth area and unit base methods. The cost is determined by multiplying the total volume of the building (obtained from length x breadth x depth) by the Local Cubic Rate, excluding costs for features like string course, cornice, corbelling, etc.

c. Unit-based method: This method calculates the structure's cost by multiplying the total units with the unit rate for each item. For schools and colleges, the unit is defined as one student, and for hospitals, it is one bed. The unit rate is derived by dividing the actual cost of a nearby similar building by the number of units.

Detailed estimate: This method of estimation is precise, involving the subdivision of the entire building work into individual items. The cost is determined by multiplying the numbers of each item by the respective completion rate

Q 38 Text Solution:

Modular ratio: Modular ratio is the ratio of modulus of elasticity of steel to modulus of elasticity of concrete.

In working stress design,

$M = \frac{280}{3\sigma_{cbc}}$

where, σ_{cbc} = Permissible stress in extreme compression fiber in concrete.

(a) $m = \frac{E_S}{E_C} = \frac{2 \times 10^5}{5000\sqrt{f_{ck}}} \times \left(1 + \theta\right) \rightarrow$ for long-term value

(b) $m = \frac{E_S}{E_C} = \frac{2 \times 105}{5000\sqrt{f_{ck}}}$ for short-term value

(c) Considering creep and shrinkage, the value of 'm' considered m $= \frac{280}{3\sigma_{cbc}}$

Where, σ_{cbc} = Permissible stresses in concrete,

θ = creep coefficient

Q 39 Text Solution:

There are two limit states:

i) Limit state of collapse: The limit state of collapse of the structure or part of the structure could be assessed from rupture of one or more critical sections and from buckling due to elastic or plastic instability or overturning. Limit state of collapse deals with the strength and stability of structures subjected to the maximum design loads out of the possible combinations. The resistance to bending, shear, torsion, and axial load at every section shall not be less than the appropriate values at that section produced by the most unfavorable combination of loads on the structures using the appropriate partial safety factors

ii) Limit state of serviceability: It ensures that your designed structure is comfortable and useable enough for human use. The serviceability limit state deals with vibrations and deflections (movements), as well as cracking and durability. It might also involve limits to non-structural issues such as fire, acoustics and heat transmission.
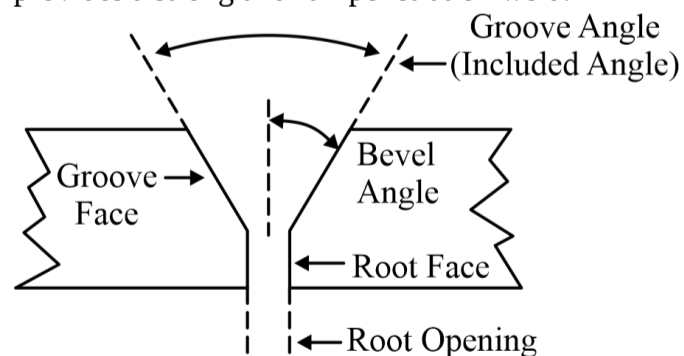
Q 40 Text Solution:

Characteristics of contours:

- All points lying on one contour have the same elevation.
- A contour will always close on itself either within or beyond the limits of the map.
- A contour closing within the limits of the map indicates either summit or a depression.
- Contours can not interact or cross each other.
- The contours are spaced equally on a uniform slope.
- Contours cross the ridge line at right angles.
- The curve of a contour in a valley is convex toward the stream.
- A single contour cannot split into two contour lines.
- Two contour lines having the same elevation can not unite and continue as one line, a single contour can not split into two lines. This is evident because a single line could, otherwise, indicate a knife-edge ridge or depression which not occur in nature

Q 41 Text Solution:

A groove weld is made in a prepared groove between two members, typically with a V. U or J shape. It provides a strong and full penetration weld.

Q 42 Text Solution:

Maximum slenderness ratio:

(a) Tension members

Description	λ_{max}
Tension member in which reversal of direct stress occurs due to live load other than wind or earthquake	180
In reversal occurs due to wind or earthquake	**350**
A tension member permanently in tension except in pretensioned members.	400

(b) Compression Members

Description	λ_{max}
A strut connected by single rivet at each end	180
Member carrying loads resulting from dead loads and imposed loads	180
A member subjected to compressive force resulting from wind/earthquake force, providing the deformation of such members does not adversely effect the stress in any part of structure.	250
Compression flange of a beam	300
Member normally acting as a tie in a roof truss or a bracing system but subjected to possible reversal of stresses resulting from the action of wind or earthquake forces	350

Q 43   Text Solution:

Turbine	Speed ratio
Pelton	0.4 – 0.5
Francis	0.6 – 0.9
Kaplan & Propeller	1.8 – 2.5

Q 44   Text Solution:

Imposed floor loads for different occupancies as specified in IS 875 (Part -2) - 1987

Building Type	Snow Load (kN/m^2)
Balconies of dwelling houses	3
All rooms and kitchens of dwelling houses	2
Dining rooms, cafeterias and restaurants in hotels, hostels, houses and boarding houses	4
Office rooms in hotels, hostels, houses and boarding houses	2.5
Toilets and bath rooms	2
Corridors, passages and staircases, including fire escapes	1.5

Q 45   Text Solution:

Secondary air pollutants are produce by the interaction among two or more primary pollutants, or by reaction with normal atmospheric constitutents with or without photoactivation.

Examples

A. Ozone

B. Formaldehyde

C. PAN (peroxy acetyl nitrate)

D. Sulphuric Acid

E. Photochemical smog, Aldehyde and ketone, HNO_3

Primary pollutants– (i) Sulphur dioxide (ii) CO (iii) Nitrogen oxides NO and NO_2 (iv) Lead (v) Hydrocarbons, halogens (vi) Radio active substances etc.

Q 46   Text Solution:
Plywood

- Wood is a hygroscopic material and has the ability to exchange its moisture content with air. Many mechanical properties are affected by changes in moisture content.

- The exchange of moisture depends upon the relative humidity and temperature of air and on the amount of water present in the wood. This relation has a great influence on the properties and quality of manufactured plywood.

- The Bureau of Indian Standards (BIS) recommends a moisture content of 5%-15% by weight for plywood. Moisture content above or below this range can have adverse effects on the manufactured products and the environment.

- The plywood boards are prepared from thin layers of wood or veneers. So Plywood is specified by the number of layers,

- The three or more veneers in odd numbers are placed one above the other with the direction of grains of successive layers at right angles to each other.

- They are held in position by application of suitable adhesives. The placing of veneers normal to each other increases the longitudinal and transverse strengths of plywood.

- The tensile strength and compressive strength along(parallel) the grain shall be greater than that across(normal) the grain.

Q 47   Text Solution:

As per the IS specifications (IS: 1130 1969) regarding the marble slabs and blocks-

The marble blocks shall be supplied in the sizes given below:

Length - 30(minimum) to 250 cm(maximum) (in stages of 10 cm)

Width- 30(minimum) to 100 cm(maximum) (in stages of 10 cm)

Thickness - 30(minimum) to 100 cm(maximum) (in stages of 10 cm)

The marble slabs shall be supplied in the sizes given below:

Length- 70(minimum) to 250 cm(maximum) (in stages of 10 cm)

Width - 30(minimum) to 100 cm (maximum) (in stages of 10 cm)

Thickness- 20(minimum) to 150 cm (maximum) (in stages of 10 cm)

Q 48   Text Solution:

Pumps operating in series: When two pumps are connected in series at the same flow rate the series pump yield high heads as compared to the individual heads produce by each pump.

$h_{net} = h_1 + h_2 + h_3 + ...+ h_n$

$Q_{net} = Q_1 = Q_2 = Q_3 = Q_n$

Pumps operating in parallel: In parallel, two pumps can simultaneously discharge a greater amount of water than the individual one.

Hence boost the discharge, if two pumps are connected in parallel.

$h = h_1 = h_2 = h_3 = h_n$

$Q_{net} Q_1 + Q_2 + Q_3 + ... + Q_n$

Q 49 Text Solution:

Unit of measurement:

Stone slab in roof	Square meter
Cutting of tree	Number
Lime concrete in foundation	Cubic meter
Pointing	Square meter
Cornice	Running length or meter

Q 50 Text Solution:

Volume of fresh concrete = 1 m^3

Mix proportion = 1 : 2 : 4

We know, 1 m^3 of freshly mixed concrete = 1.54 m^3 dry volume of concrete

(a) Volume of cement = $\frac{1 \times 1.54}{7} = 0.22$ m^3

1 m^3 of cement = 1500 kg by weight

0.22 m^3 of cement = 1500 × 0.22 = 330 kg

(b) Volume of fine aggregate = $\frac{2}{7} \times 1.54$ =0.44 m^3 of fine aggregate

(c) Volume of coarse aggregate = $\frac{4}{7} \times 1.54 = 0.88$ m^3 of coarse aggregate

Q 51 Text Solution:

Given that,

monthly rent = 12000

Yearly or annual gross rent (A$_g$) = 12 × 12000 = 144000

Annual outgoing (O) = 12000

Land cost = 600,000

Rate of interest = 6%.

We know, then,

Net income = gross rent – outgoing Net income

= 144000 – 12000 = 132000 Rs.

Then, the value of property = Capital value + Land cost

Capital value = Net income × year's purchase
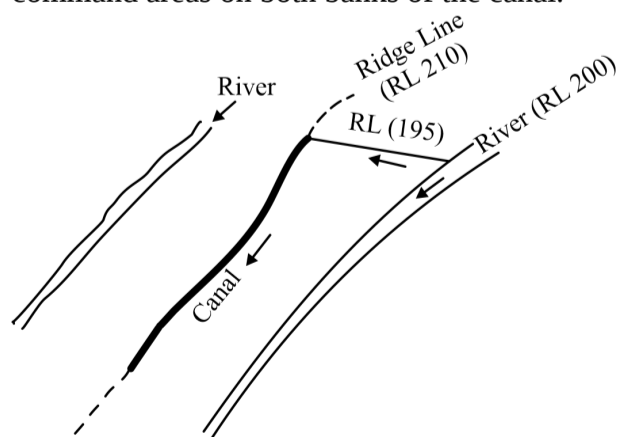
$Year's\ purchase = \frac{100}{Rate\ of\ interes}$

Capital value = $132000 \times \frac{100}{6}$ = 22,00,000 Rs.
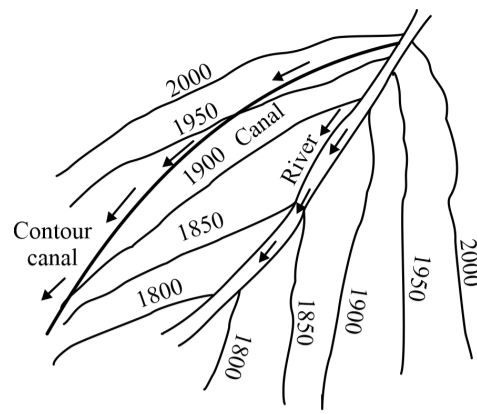
Value of property = 2200, 000 + 600,000 = 2800,000 Rs.
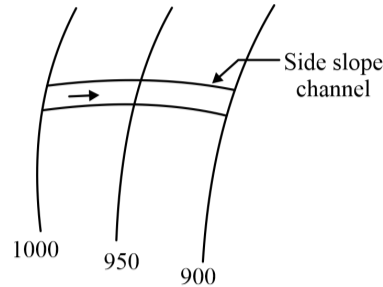
Q 52 Text Solution:

Ridge canal aligned along a watershed, Dcan command areas on both banks of the canal.

Contour canal aligned nearly parallel to the contours of the area, irrigation possible on one side of the canal only.

Side slope canal is constructed at right angles to the contours & does not intercept any cross drainage.

Q 53 Text Solution:

Inundation Canal draw supplies from a river when there is a high stage in the river, not provided with headworks for the diversion of river water to the canal.

Given that,

Weight of liquid (w) = 15 N

Volume (V) = 6 lit = 6 × 10^{-3} m^3

We know,

Specific weight = $\frac{Weight\ of\ liquid}{Volume}$

Specific weight = $\frac{15}{6 \times 10^{-3}}$ = 2500 N/m^3

Q 54 Text Solution:

Varnish: Varnish is a solution of resin or resinous substance dissolved in alcohol, turpentine or spirit. It is used to protect & improve the appearance of wood, metal & other surfaces.
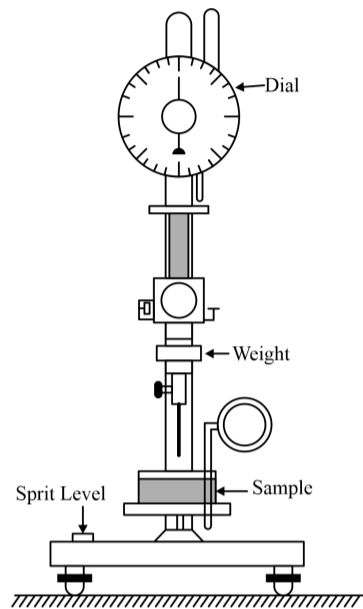
Q 55 Text Solution:

1. Viscosity test It is a measure of resistance to flow. It is conducted to check consistency and flow resistance of bitumen. Viscosity of a cut back can be measured with either 4 mm orifice at 25°C or 10 mm orifice at 25 to 40oC. Measured by efflux viscometer. Fural viscosity is tandard test.
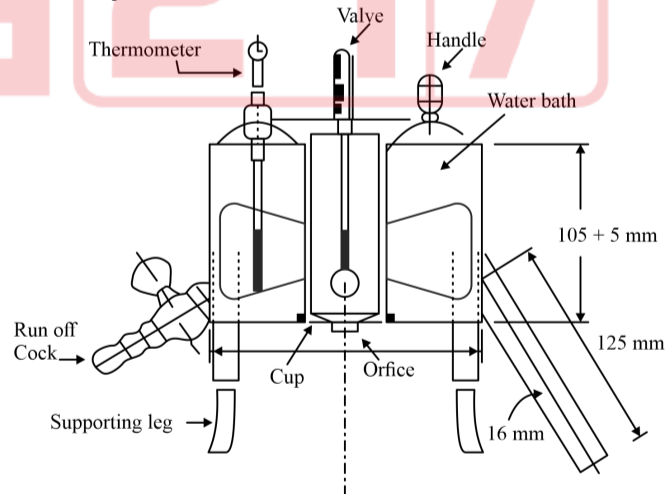
2. Softening point test Ring and ball apparatus are used to fine softening point. It is the temperature at which the bitumen attains a particular degree of softening. The diameter of steel ball is 0.95 cm, constant 5-6°C temperature is increased per minute. It is conducted at 35 to 70°C
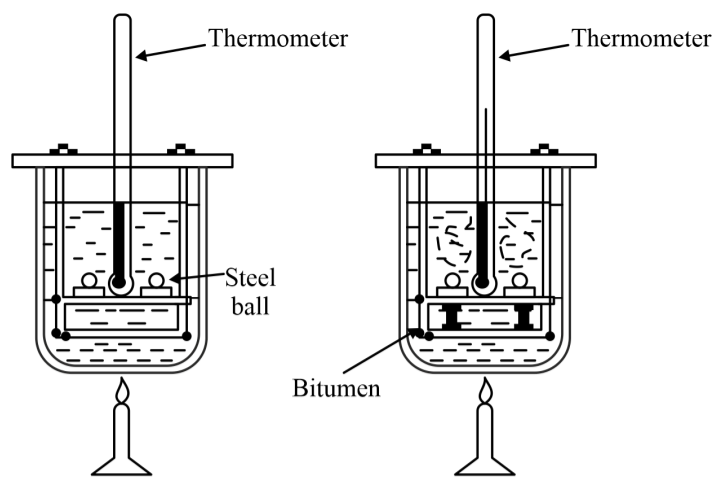
3. Penetration test Penetration test on bitumen is used for determining its grade. The needle is allowed to penetrate for 5 seconds. Penetration test is conducted at 25°C

4. Ductility test Ductility is defined as the distance in cm, to which a standard sample or briquette of the material will be elongated without breaking. Rate of pull is 50 mm per min.

Q 56 **Text Solution:**

Initial Consolidation:
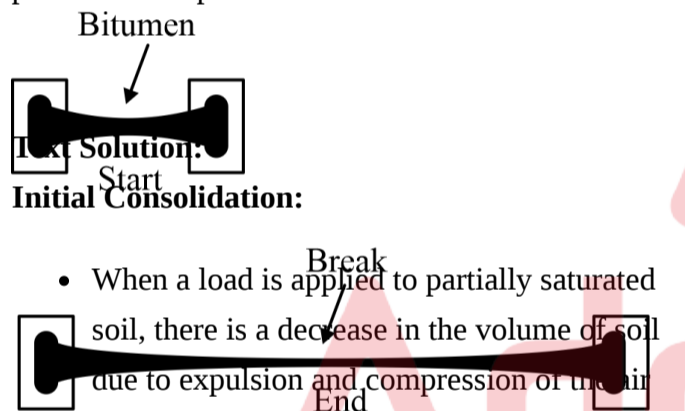
- When a load is applied to partially saturated soil, there is a decrease in the volume of soil due to expulsion and compression of the air voids. Also, a small decrease in the volume of soil occurs due to the compression of solid particles.
- The reduction in the volume of soil just after the application of load is called initial consolidation.
- For saturated soils, the initial consolidation is mainly due to the compression of solid particles.

Q 57 **Text Solution:**

1. Dicken's formula:- This formula is applicable in North India

$Q_p = C_D A^{3/4}$

Where, C_D= Dicken's Constant, A = Area of catchment

2. Ryve's formula: - Applicable in South India

$\boxed{Q_p = CA^{2/3}}$

3. Ingli's formula: - Applicable in Maharashtra Region

$\boxed{Q_P = 123.2\sqrt{A}} = \frac{124A}{\sqrt{A+10.4}}$

Q 58 **Text Solution:**

Given that,

Base period (B) = 120 days

Depth of water (Δ) = 20 cm + 32 cm + 25 cm + 13 cm = 90cm

= 0.90 m

We know,

Duty (D) = $\frac{8.64B}{\Delta}$ hect/cumec

= $\frac{8.64 \times 120}{0.90}$

D = 1152 hac/cumec

Q 59 **Text Solution:**

Vehicle or drying oils:

- The vehicle is the liquid substance that holds the ingredients of paint in liquid suspension.
- They are required mainly for two reasons:
- To make it possible to spread the paint evenly and uniformly on the surface in the form of a thin layer.
- To provide a binder for the ingredients of paint so that they may stick or adhere to the surface
- Example:- **Linseed oil**, Tung oil, Poppy oil, Nut oil, etc

Q 60 **Text Solution:**

Given that,

Simple circular curve, Radius (R) = 600 m

Deflection angle (Δ) = 120°

We know that,

Value of versed sine of a curve

= $R\left[1-\cos\frac{\Delta}{2}\right]$

= $200\left[1-\cos\frac{120}{2}\right]$

= 300 m

Q 61 **Text Solution:**

Geological classification:

Sedimentary rock - formed by the weathering action of existing rock. Ex. Sand stone, Limestone, Shales, Gravel, Lignite.

Igneous Rock - formed by cooling & solidification of magma & lava. Ex. Trap, Dolerite, Rhyolite, Syenite, Pegmatite, Diorite, Basalt,

Metamorphic Rock - Igneous & Sedimentary rocks have undergone considerable change with high pressure & temperature. Ex- Marble (made from limestone), Quartzite (made from sandstone), Static.

Q 62 **Text Solution:**

- **GPS Receivers** - A GPS receiver is an L-band radio processor. It processes the signal broadcast by GPS satellites, solves the equations for navigation so that user can easily compute their position, precise time & velocity.
- **Self-contained:** Self-contained receivers have a screen and is integrated with the computer itself. Sometimes, additional features e.g. electronic compass, barometer etc. are found in this type. It is primarily used in boating and aviation.

- **Carrier Phase receivers:** These receivers provide 10-30 cm GPS position accuracy with differential correction. The distance from the receiver to the satellite is measured by determining the total number of waves which supports the C/A code signal, which is more accurate and takes about 5 minutes of the occupation time
- **Dual-Frequency receivers:** provide GPS position accuracy according to differential correction within sub centimeter & accuracy according to survey grade. These receivers are presented with the signals from satellites on the basis of two frequencies at the same time. The use of two frequencies will help in omission of atmospheric and other errors and thus improving the accuracy.

Q 63 Text Solution:

Given,

Length = 3 m,

Given case effective held in position and restrained against rotation at one end and at other end restrained against rotation but not held in position.

Effective Length (l) = 1.2 L = 1.2 × 3

Effective Length (l) = 3.6 m

Q 64 Text Solution:

Parameter	Acceptable limit	Permissible Limit
Total suspended solids (mg/L)	500	2000
Turbidity (NTU)	1	10
Colour (NTU)	5	25
Taste& Odour (TON)	1	3
Total dissolved solids (mg/L)	500	2000
Alkalinity (mg/L as $CaCO_3$)	200	600
pH	7-8.5	< 6.5 & > 9.2
Hardness (mg/L as $CaCO_3$)	200	600
Chloride content (mg/L)	250	1000
Free ammonia (mg/L)	0.15	0.15
Nitrite (mg/L)	0	0
Nitrate (mg/L)	45	No Relaxation
Fluoride content (mg/L)	1	1.5
Sulphate (mg/L)	200	400
Calcium (mg/L)	75	200
Free residual Chlorine (mg/L)	0.2	1

Q 65 Text Solution:

Given,

Original cost = 30,00,000

Scrape value = 3,00000,

Life in year = 30 years

Annual depreciation= $\frac{\text{original cost}-\text{scrape value}}{\text{life in year}}$

$= \frac{3000000-300000}{30}$

Annual depreciation = 90,000

Q 66 Text Solution:

Standard density = 1440 kg/m^3

Weight of 1 bag of cement = 50 kg

Volume of 1 bag of cement = $\frac{50}{1440}$ = 0.0347 m^3 = 34.7 litre

Q 67 Text Solution:

Lehmann's method

- Locating the position of a plane table station with reference to three point is known as three point problem.
- The trial and error method of three point problem also known as Lehman's method.
- The accuracy with which a plane table station can be located through three-point problem is known as its fix.
- In plane tabling failure of fix occurs when the plane table is on the great circle.

Q 68 Text Solution:

Varnish: Varnish is the nearly homogenous solution of resins in oil, alcohol, or turpentine. Type of solvent used depends upon the type of resin used.

French Polish: It is a type of spirit varnish prepared by dissolving the resin in Methylate spirit at room temperature for use on hardwood substance to hide the grain defects. The surface is made smooth by rubbing.

Wax Polish: It consists of beeswax dissolved in turpentine and is used for highlighting the grain over wooden surfaces. The polish is rubbed over the surface with the rag until a bright appearance is obtained.

Q 69 Text Solution:

Allen Hazen Equation:

$K = CD_{10}^2$

where,

k = coefficient of permeability in cm/s,

C = constant (100 to 150),

D_{10} = effective size in cm.

This equation gives an empirical value of permeability.

- On the other hand, in a partially saturated soil, the pore spaces are filled with both air and water. Water, being a polar molecule, tends to adhere to soil particles, making it harder to flow through the mixture of air and soil. Air, being non-polar and having lower viscosity, doesn't transmit water as effectively as a fully liquid medium would.
- In a fully saturated soil, every pore is filled with water, allowing water to flow continuously and unhindered through the interconnected network of voids. This results in higher permeability.

Q 70 Text Solution:

Tie: Resists tension forces, prevents separation. Ties are commonly used in structures such as trusses, bridges & cranes.

Boom: Boom is a horizontal member which primarily resists bending moments. It experiences both tension & compression forces along it's length. Booms are often found in structures like cranes, where they provide horizontal reach for lifting loads.

Joist: Horizontal member supporting floors or ceilings in buildings. They are often made of wood, steel, or concrete.

Strut: Compression member resisting compressive forces, often used in bracing
systems. Struts are commonly used in structures like trusses, frames & walls.

Q 71 Text Solution:

Annuity: The annual payments (paid in months or year) paid for capital amount invested party.

(a) Annuity Due: The amount paid at the beginning of each period or year for definite number of intervals.

(b) Perceptual Annuity: The payments of the annuity continue for indefinite period.

(c) Deferred Annuity: The payments of the annuity begined after some years.

Q 72 Text Solution:

Turnout: A turnout is provided on a railway track to provide facilities for turning of vehicles from one track to another. It consists of a pair of points (switches), four lead rails, two check rails, and a crossing. Turnout enables either a branch line or sliding to take off from another track

Turn out diagram
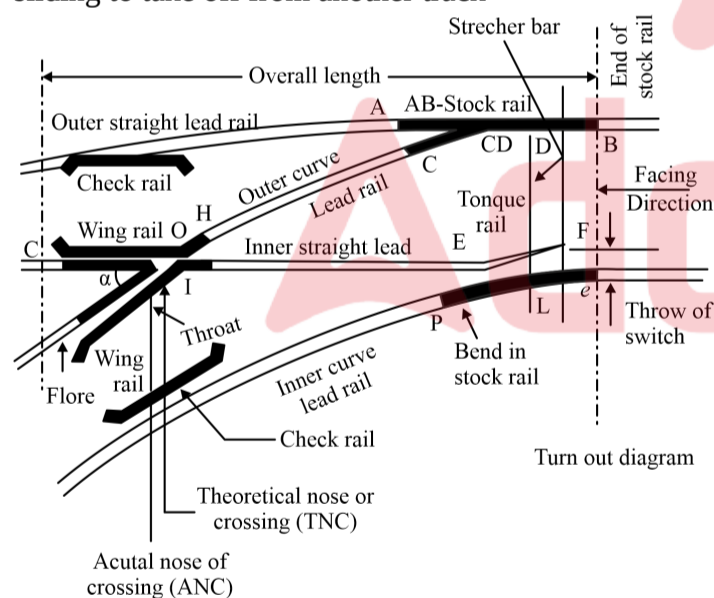
Stock rail: The running rail against which the tongue rail operates is called the Stock rail.

Crossing: A crossing is an arrangement provided at the junction/intersection where the two rails cross each other. The objective of providing crossing is to allow the passing of the wheel flange of the vehicle from one track to another.

Tongue rail: It is a tapered movable rail that is composed of high carbon or high manganese steel.

- it is attached to a running rail at the thicker end.
- A tongue rail is also called a switch rail.

Points or switch: A pair of tongue and stock rails alongside the connections and fittings are called Points or Switches.

Q 73 Text Solution:

Name of item	Measurement unit
Expansion joint	Running meter
Flooring work	Square meter
Damp proof course	Square meter
Cement Concrete	Cubic meter
Half brick wall	Square meter
Well sinking, pile driving, Dagbelling, Grouting of cracks or joints, Supply of pipes, Skirting, cornice	Meters
Plastering, pointing, Dado, White Washing, distempering, painting, polishing, coal tarring, removing of paint	Square meters
Tile roof, slate roofing, timber roofing, Ceiling, centering and shuttering, Damp proof course, Turfing or lining of canal, surface dressing or leveling, jail work or Jafri work, Woodwork indoors and shutters, sawing of timber, woodwork in partition and plywood.	Square meters
Boring holes in iron, painting letters, and figures, ornamental pillar caps, cleaning flues, cotton cords in skylight, Easing doors and windows, Fixing doors and windows	Numbers
Earthwork in excavation, puddling, Quarrying of stones, concreting, brickwork in the foundation, stone masonry	Cubic meters
Rolled steel joists, steel reinforcement bars, binding of steel reinforcement, fabrication, and hoisting of steelwork	Quintals

Q 74 Text Solution:

Noise Pollution: It is caused due to unwanted loud sounds in our surroundings.

Consequences of noise pollution:

- High blood pressure
- Headaches
- Heart diseases
- Sleep irregularities
- Stress
- Hearing loss.

Q 75 Text Solution:

Text ur al classification of soil is based on grain size only.

This refers to the Unified Soil Classification System (USCS), where soil is classified based on the percentage of particles in different size ranges (gravel, sand, silt, and clay).

This system primarily focuses on grain size distribution for classification.

Particle size (in mm)

Q 76 Text Solution:

Zero air voids line: It means the soil is fully saturated, with the air not present in the pores of the soil mass. It is obtained from the compaction test. The zero air void line was drawn with the results, obtained from the compaction test as shown below.
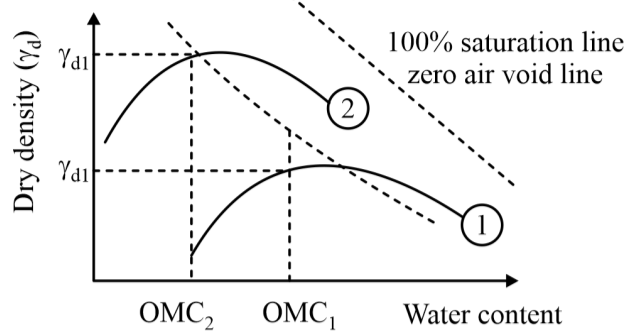
Q 77 Text Solution:

Canal lining: It is the process of covering or lining the earthen surfaces of a canal with stable, nonerodible lining surfaces such as concrete, tiles, asphalt etc.

Advantages of lining a canal are the following:

- To minimise the seepage losses in canal.
- To increase the discharge in canal section by increasing the velocity.
- To prevent erosion of bed and side due to high velocity.
- To retard the growth of weeds.
- To reduce maintenance of canal.
- The increased velocity minimises the losses due to evaporation.

Q 78 Text Solution:

As per Indian standards, the minimum length of a tongue rail for a broad-gauge railway track is 3660 mm. It ensures smooth entry to the switch while maintaining safety & preventing derailment. A tongue rail is tapered having toe at one end & heel at the other end.

Q 79 Text Solution:

Given,

Young's modulus of elasticity ratio $= \frac{E_1}{E_2} = 2.5$

$$E_1 = 2.5 \, E_2$$

Area is same, $A_1 = A_2$

Load is same, $P_1 = P_2$

We know that, $\Delta l = \frac{PL}{AE}$

So,

$$\frac{\Delta l_1}{\Delta l_2} = \left(\frac{\frac{P_1 L_1}{A_1 E_1}}{\frac{P_2 L_2}{A_2 E_2}} \right)$$

$$\frac{\Delta l_1}{\Delta l_2} = \frac{E_2}{E_1} = \frac{E_2}{2.5 E_2}$$

$$\frac{\Delta l_1}{\Delta l_2} = 0.4$$

Q 80 Text Solution:

Given,

Kinematic viscosity (ν) = 0.01 × 10⁻⁴ m²/s

Diameter of pipe (D) = 200 mm.

Velocity (V) = 5 m/s

Reynolds number (Re) = ?

$$R_e = \frac{VD}{v} = \frac{5 \times (0.2)}{0.01 \times 10^{-4}} = 1 \times 10^6$$

Q 81 Text Solution:

Plate girders are typically used as long-span floor girders in buildings, as bridge girders, and as crane girders in industrial structures.

- Plate girders are at their most impressive in modern bridge construction where main spans of well over zoom are feasible, with corresponding cross-section depths, launched over the supports, in the range of 5-10 m.
- When the moment resisting capacity of the plate girder has to be increased, flange cover plates are provided over flange angles. The moment of inertia and consequently the moment-resisting capacity of the girder is increased considerably as the flange cover plates are at the greatest distance from the neutral axis.
- The flange cover plates should not be thicker than the flange angles in riveted/bolted connections. Hence, if necessary more than one plate may be required. It is preferred that all cover plates should have same or less thickness than flange angle.

Plate girder   Cross section view
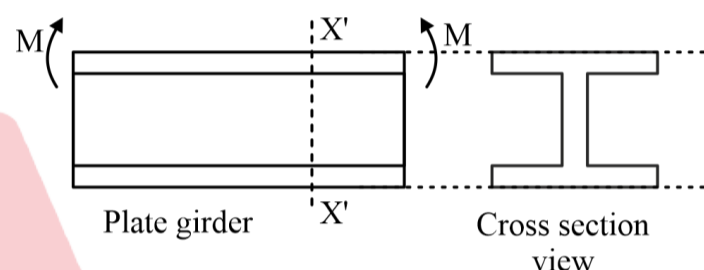
Q 82 Text Solution:

The bending moment at A (from left)

$$= 9 \times 1.5 \times \frac{1.5}{2} = 10.125 \text{ kN-m}$$

The bending moment at B (from right)

$$= 3 \times 1.5 \times \frac{1.5}{2} = 3.375 \text{ kN-m}$$

Thus sum of moments = 10.125 + 3.375 = 13.50 kN-m

Q 83 Text Solution:

Given,

Time from start of rainfall (minutes)	Cumulative rainfall (mm)
0	0
15	6
30	15
45	15
60	30
75	35
90	45

The intensity of rainfall during the time interval (0 to 15 is more than the intensity of rainfall during the time interval 60 to 75.)

(i) Intensity of rainfall during to 0 to 15 minutes

$$= \frac{6 \text{ mm}}{15} \times 60 = 24 \text{ mm/s}$$

(ii) Intensity of rainfall during 60 to 75 minutes

$$= \frac{5 \text{ mm}}{15} \times 60 = 20 \text{ mm/s}$$

Note- (ii) < (i)

These in no rainfall during the time interval 30 to 45 minutes.

Intensity of rainfall during 30 to 45 minutes

$$\frac{0}{15} \times 60 = 0$$

Q 84 Text Solution:

S. No	Defect due to	Types
1.	Conversion	Chip mark Diagonal grain

		Tom grain Wane
2.	Insect	Marine Boners Beetles Termites
3.	Fungi	Blue Rot Heart Rot Dry Rot Sap stain Wet Rot
4	Seasoning	Bow Check Collapse Cup Twist Split Warp
5.	Natural Forces	Knots Burb Rindgall Twisted fiber Shaker

Q 85 Text Solution:

Forms of precipitation

Raindrops - Raindrops or rain is the most observed kind of precipitation in the atmosphere. Clouds are formed of water droplets, dirt and dust. When the amount of water droplets exceeds and the cloud becomes heavy, they fall down onto the surface of earth. Raindrops can have a diameter of 6mm.

Snowflakes - When the temperature freezes the tiny cloud droplets, snow crystals are formed. It is basically flaky ice crystals that have an average density of 0.1g/cc. Water vapours being large in number, force the ice droplets to evaporate, ice crystals grow at the expense of these droplets.

Sleet - The rain that freezes or partially freezes when falling from the sky is known as sleet. Sleet only occurs during winters when air is at sub freezing temperature.

Hail - Hail is supercooled water, which is refrozen in the atmosphere, before it falls back to the ground as a small ball of ice of size more than 8 mm.

Glaze - It is ice coating formation when rain or drizzle comes in contact with cold object on the ground.

Q 86 Text Solution:

A horizontal curve is a curve in plan to provide a change in direction to the central line of a road.

- When a vehicle traverses a horizontal curve, the centrifugal force acts horizontally outwards through the center of gravity of the vehicle.
- The ratio of the centrifugal force to the weight of the vehicle, P/W is known as the centrifugal ratio or the impact factor.
- The centrifugal ratio is thus equal to $\frac{v^2}{gR}$
- In a horizontal curve, the superelevation is provided at an increasing rate with zero at the start to the maximum value at the end of the transition curve.

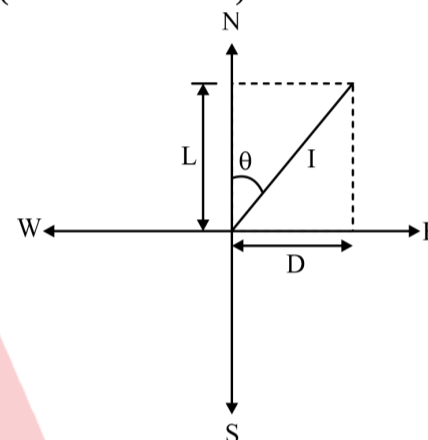**Q 87 Text Solution:**

Copper sulphate:

- Copper sulphate is used to control the algae present in water.
- It is a very powerful oxidizing agent so it is toxic.
- When it is added to water it can kill bacteria, algae, plants, fungi, etc.
- The heavy concentration of copper sulphate in water is killing the vegetation.
- This decay of vegetation creates a scarcity of dissolved oxygen.
- Thus killing of fish starts over there.

Q 88 Text Solution:

Traverse computations:- The position of different points are plotted on a plan with reference to two lines which are respectively parallel and perpendicular to the meridian.

Latitude:- The latitude of the line may therefore defined as the distance measured parallel to the meridian (north and south line).

Departure:- Departure defined as the distance measured parallel to the line perpendicular to the meridian (east and west line).

L = Latitude is the projection on North-South meridian

D = Departure is the projection on East-West meridian

θ = Bearing angle

| = Length of the line.

L = l cos θ

D = l sin θ

Differential levelling: The method of direct levelling the object of which is solely to find out the difference in elevation of two points regardless of the horizontal positions of the points with respect of each other, is known as differential levelling.

Q 89 Text Solution:

Max displacement allowed D (in cm) = $\frac{lSin\,\Delta}{S}$

Max displacement allowed D = 0.5 mm = 0.05 cm
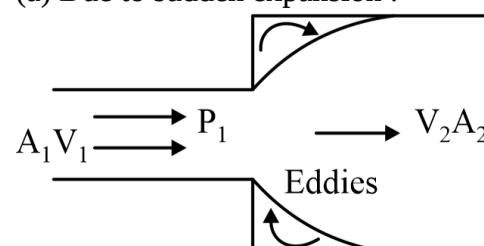
Deflection angle $(D) = 5°$

 Scale= 1 (cm) : S (meter), S = 20 m

∴ max length of offset $l = \frac{0.05 \times 20}{\sin 5°}$

$\boxed{l = 11.467\text{m}}$

Q 90 Text Solution:
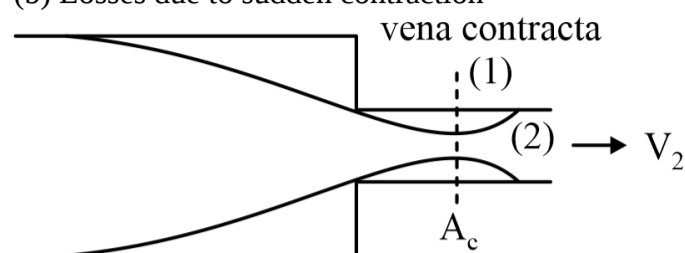
Minor losses

(a) Due to sudden expansion : -

$h_L = \frac{(V_1 - V_2)^2}{2g}$

A_1 = Area of smaller diameter pipe

A_2 = Area of bigger diameter pipe

V_1 = Velocity of smaller diameter pipe

(b) Losses due to sudden contraction

$h_L = \frac{(V_C - V_2)^2}{2g} = \frac{KV_2^2}{2g} = \frac{0.5V_2^2}{2g}$

where $K = \left(\frac{1}{C_C} - 1\right)^2$, $C_C = \frac{A_c}{A_c}$

Special Points:

- Momentum equation and Bernouilli's equation are uses in derivation of losses
- Loss in expansion is much higher than loss in contraction
- Losses are always expressed in terms of velocity of smaller diameter pipe.

(c) Exit loss (due to impact)

$h_L = \frac{KV^2}{2g}$

(d) Entry loss

$h_L = \frac{0.5V^2}{2g}$

(e) Loss due to pipe fittings and bends

$h_L = \frac{KV^2}{2g}$

| Type of fitting	K
Standard Tee	1.8
Standard Elbow	0.9
45° Elbow	0.4
90° Bend T (Sharp)	1.2
Gate valve (half open)	5.6
Angle valve	5
Foot valve of pump	1.5

Q 91 Text Solution:

According to IS 2386 (Part IV): 1963, the correct set of sieves used for this test is 2.36 mm, 10 mm, 12.5 mm.

Crushing test : - It gives strength of Aggregates.

Aggregate crushing value $= \frac{W_2}{W_1} \times 100$

- Aggregates passing from 12.5 mm & retained on 10 mm.
- Then filled in cylinder of 11.5 cm diameter & 18 cm height in 3 layers.
- Each layer tamped 25 times & weighted W_1
- Then sample is subjected to 40 tonnes of load at the rate of 4 (sometimes 5) tones per minute.
- Crushed aggregate passed through 2.36 mm sieve & passing material weighs W_2.

Crushing test set up
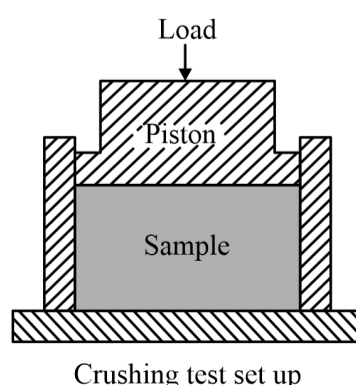
- Crushing value for surface course should be less than 30% & should not exceed 45% for base course.
- A value less than 10 shows strong aggregate while above 35 shows Weak aggregate.
- For the Bituminous concrete, a maximum value of 35 is specified.
- A maximum value of 40% is allowed for WBM base course in Indian Conditions.

Q 92 Text Solution:

Check for Deflection : -

As per Clause 23.2 of IS 456, stipulates the limiting deflections under two heads as given below :-

a. The maximum final deflection should not more than span/250 due to all loads including the effects of temperature, creep & shrinkage & measured from the cast level of the supports of floors, roof & all other horizontal members.

b. The maximum deflection should not more than the lesser of span/350 or 20 mm including the effects of temperature, creep & shrinkage occurring after erection of partitions & the application of finishes.

Q 93 Text Solution:
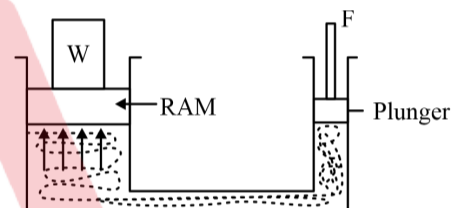
$\frac{W}{A} = \frac{F}{a}$

W = 30 kN

A = 30 × 30 = 900 cm^2

a = 4 × 4 = 16 cm^2

F = ?

$F = \frac{w \times a}{A} = \frac{30 \times 10^3 \times 16}{900} = 533.33$ N

Q 94 Text Solution:

As per section 6.1: IS 1121-1974 (part IV)

The shear strength of the test piece shall be calculated as follows

$S = \frac{W}{2A}$

Where, S = shear strength (kg/cm^2)

W = total maximum load in kg indicated by the testing machine

A = area of the center cross-section of the test piece (cm^2). (Ref. sec 6.1; IS 1121 part IV- 1974)

The durability of the stone shall be expressed in percentage as a change in the weight of the specimen. (As per section 5.2, of IS 1126-1974)

Q 95 Text Solution:

Types of Jump : -

It depends on the Froude's number of the incoming flow (upstream end).

	Fr	E_L/E_1	Water surface
undular	1-1.7	≈0	Undulating
Weak	1.7–2.5	5–18%	small rollers form
Oscillating	2.5–4.5	18–45%	Water moving in random manner

Steady	4.5–9	45–70%	Roller & jump action
Strong	≥ 9	$\geq 70\%$	Very rough & choppy

- Lead is a neurotoxin, which can damage the 28 brain & nervous system, leading to mental retardation and behavioral disorders, specially in children.

Q 96 Text Solution:

Bernoulli's equation states that for an ideal fluid flowing steadily, the total energy at any point is constant i.e. the sum of the kinetic energy, potential energy & pressure energy at any point in the flow is equal to the sum of these energies at any other point in the flow.

- Euler's equation is a more general equation that describes the motion of a fluid.
- The momentum equation relates the forces acting on a fluid element to its acceleration

Q 97 Text Solution:

Combined correction = $0.0673 \, (d)^2$

$$d = 2.5 \text{ km}$$

Combined correction = $0.0673 \times (2.5)^2$

$$= 0.420 \text{ m}$$

Q 98 Text Solution:

Slenderness ratio(λ) of column:

It is the ratio of its effective length or unsupported length to the least lateral dimension of the column. The relevant clause from IS 456-2000: 25.3.1, The unsupported length between end restraints shall not exceed 60 times the least lateral dimension of a column.

Q 99 Text Solution:

It is minimum water content at which soil is completely saturated or the maximum water content at which further reduction in water content does not cause any decreases in the volume of soil sample
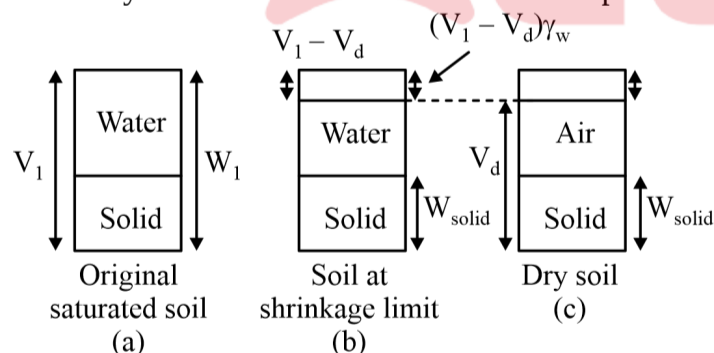
Q 100 Text Solution:

Sulphur dioxide can contribute to respiratory problems & acid rain, it is not radioactive & does not directly cause cancer. It can create reactive oxygen species, which can contribute to oxidative stress, linked to cancer development.

- Carbon monoxide binds to hemoglobin more readily than oxygen, reducing the amount of oxygen transported throughout the body. Hence, statement is correct.
- Nitrogen dioxide is a lung irritant that can contribute to bronchitis, pneumonia & other respiratory illnesses. Hence, statement is correct.