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GATE SOLVED PAPER
Civil Engineering
2003

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GATE SOLVED PAPER - CE

2003

Q. 1 In the design of lacing system for a built-up steel column, the maximum allowable slenderness ratio of a lacing bar is

(A) 120 (B) 145

(C) 180 (D) 250

Q. 2 Which of the following elements of a pitched roof industrial steel building primarily resists lateral load parallel to the ridge ?

(A) bracings (B) purlins

(C) truss (D) columns

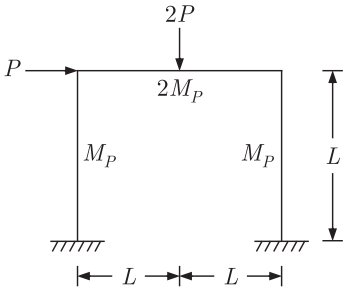
Q. 3 List-I contains some elements in design of a simply supported plate girder and List II give some qualitative locations on the girder. Match the items of two lists as per good design practice and relevant codal provisions.

	List I		List II
a.	Flange splice	1.	At supports (minimum)
b.	Web splice	2.	Away from centre of span
c.	Bearing Stiffeners	3.	Away from support
d.	Horizontal stiffener	4.	In the middle of span
		5.	Longitudinally somewhere in the compression flange

Codes :

	a	b	c	d
(A)	2	3	1	5
(B)	4	2	1	3
(C)	3	4	2	1
(D)	1	5	2	3

Q. 4 A steel portal frame has dimensions, plastic moment capacities and applied load as shown in the figure. The vertical load is always twice of the horizontal load. The collapse load P required for the development of a beam mechanism is



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(A) $\frac{3M_P}{L}$ (B) $\frac{4M_P}{L}$

(C) $\frac{6M_P}{L}$ (D) $\frac{8M_P}{L}$

Common Data For Questions. 5 & 6

A truss tie consisting of 2 ISA $75 \times 75 \times 8$ mm carries a pull of 150 kN. At ends the two angels are connected, one each on either side of a 10 mm thick gusset plate, by 18 mm diameter rivets arranged in one row. The allowable stresses in rivet are $f_s = 90.0$ N/mm^2 and $f_{br} = 250$ N/mm^2.

Q. 5 Maximum tensile stress in the tie in N/mm^2 is

(A) 93.6 (B) 87.5

(C) 77.2 (D) 66.0

Q. 6 Minimum number of rivets required at each end is

(A) 2 (B) 3

(C) 4 (D) 5

Q. 7 Given Matrix $[A] = \begin{bmatrix} 4 & 2 & 1 & 3 \\ 6 & 3 & 4 & 7 \\ 2 & 1 & 0 & 1 \end{bmatrix}$, the rank of the matrix is

(A) 4 (B) 3

(C) 2 (D) 1

Q. 8 A box contains 10 screws, 3 of which are defective. Two screws are drawn at random with replacement. The probability that none of the two screws is defective will be

(A) 100% (B) 50%

(C) 49% (D) None of these

Q. 9 If P, Q and R are three points having coordinates $(3, -2, -1)$, $(1,3,4)$, $(2,1-2)$ in XYZ space, then the distance from point P to plane OQR (O being the origin of the coordinate system) is given by

(A) 3 (B) 5

(C) 7 (D) 9

Q. 10 If L defines the Laplace Transform of a function, $L[\sin(at)]$ will equal to

(A) $\frac{a}{s^2 - a^2}$ (B) $\frac{a}{s^2 + a^2}$

(C) $\frac{s}{s^2 + a^2}$ (D) $\frac{s}{s^2 - a^2}$

Q. 11 The Fourier series expansion of a symmetric and even function, $f(x)$ where

$$f(x) = 1 + (2x/\pi),\ -\pi \le x \le 0$$

and $$= 1 - (2x/\pi),\ 0 \le x \le \pi$$

will be

(A) $\sum_{n=1}^{\infty} \frac{4}{\pi^2 n^2}(1 + \cos n\pi)$ (B) $\sum_{n=1}^{\infty} \frac{4}{\pi^2 n^2}(1 - \cos n\pi)$

(C) $\sum_{n=1}^{\infty} \frac{4}{\pi^2 n^2}(1 - \sin n\pi)$ (D) $\sum_{n=1}^{\infty} \frac{4}{\pi^2 n^2}(1 + \sin n\pi)$

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Q. 12 The results of analysis of raw water sample are given below :

Turbidity	:	5 mg/L	pH	:	7.4
Fluorides	:	2.5 mg/L	Total Hardness	:	300 mg/L
Iron	:	3.0 mg/L	MPN	:	50 per 100 mL

From the data given above, it can be inferred that water needs removal of

(A) turbidity followed by disinfection

(B) fluorides and hardness

(C) iron, followed by disinfection

(D) fluorides, hardness and iron followed by disinfection

Q. 13 Zero hardness of water is achieved by

(A) lime soda process

(B) excess lime treatment

(C) ion exchange treatment

(D) excess alum and lime treatment

Q. 14 Which of the following sewage treatment methods has inherent problems of odour, ponding and fly nuisance ?

(A) UASM system

(B) Activated sludge process

(C) Trickling filters

(D) Stabilization ponds

Q. 15 From amongst the following sewage treatment options, largest land requirements for a given discharge will be needed for

(A) trickling filter (B) anaerobic pond

(C) oxidation ditch (D) oxidation pond

Q. 16 Results of a water sample analysis are as follows :

Cation	Concentration (mg/L)	Equivalent Weight
Na^+	40	23
Mg^{+2}	10	12.2
Ca^{+2}	55	20
K^+	2	39

(milli-equivalent weight of $CaCO_3 = 50$ mg/meq).

Hardness of the water sample in mg/L as $CaCO_3$ is

(A) 44.8 (B) 89.5

(C) 179 (D) 358

Q. 17 An ideal horizontal flow settling basing is 3 m deep having surface area 900 m^2. Water flows at the rate of 8000 m^3/d, at water temperature 20°C ($\mu = 10^3$ kg/m -s and $\rho = 1000$ kg/m^3). Assuming Stoke's law to be valid, the proportion (percentage) of spherical sand particles (0.01 mm in diameter with specific gravity 2.65), that will be removed, is

(A) 32.5 (B) 67

(C) 87.5 (D) 95.5

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Q. 18 Match List-I (Type of water impurity) with List-II (Method of treatment) and select the correct answer using the codes given below the lists :

	List-I		List-II
a.	Hardness	1.	Reverse Osmosis
b.	Brackish water from sea	2.	Chlorination
c.	Residual MPN form filters	3.	Zeolite Treatment
d.	Turbidity	4.	Coagulation and Flocculation
		5.	Coagulation, Flocculation and Filtration

Codes :

	a	b	c	d
(A)	1	2	4	5
(B)	3	2	2	4
(C)	2	1	3	5
(D)	3	1	2	5

Q. 19 Settling test on a sample drawn from Aeration Tank liquor of ASP ($MLSS = 2800$ mg/L) was carried out with 1 litre sample. The test yielded a settled volume of 200 mL. The value of Sludge Volume Index shall be

(A) 14.0

(B) 34.2

(C) 71.4

(D) 271

Q. 20 Match List-I Characteristics of sewage discharged into inland waters) with List-II (Allowable limit, mg/L) and select the correct answer using the codes given below the lists :

	List-I		List-II
a.	BOD_5	1.	250
b.	COD	2.	30
c.	Oil and Grease	3.	20
d.	Total Suspended Solids	4.	10
		5.	5
		6.	3

Codes :

	a	b	c	d
(A)	2	5	4	2
(B)	4	1	6	4
(C)	3	1	4	2
(D)	2	1	6	3

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Common Data For Questions. 21 and 22

A water treatment plant treating 10 MLd to water requires 10 mg/L of filter Alum, $Al_2(SO_4)_3.18H_2O$. The water has 6 mg/L of alkalinity as $CaCO_3$.
(Al = 26.97, S = 32, O = 16, H = 1, Ca = 40 and C = 12).

Q. 21 Total alkalinity requirement (10^6 mg per day as $CaCO_3$) matching filter Alum, shall be

(A) 180 (B) 120

(C) 90 (D) 60

Q. 22 Quantity of Quick Lime required (10^6 mg per year as CaO) shall be

(A) 2132 (B) 3000

(C) 4132 (D) 6132

Common Data For Questions. 23 and 24 :

A conventional Activated sludge Plant treating 1000 m^3/d of municipal waste water disposes of its anaerobically digested sludge on relatively impervious farmland. Use the following data :

1. Raw Sewage : SS = 225 mg/L (70% volatile)
   BOD = 190 mg/L
   (Excess activated sludge returned to primary)
2. Primary Settling : SS - 50% removal
   BOD - 30 % removal
3. Excess Activated Sludge : 0.4 g VSS produced per g BOD applied (80% volatile of total)
4. Anaerobic Digester : VSS reduced 50%
   Digested sludge concentration - 60% Sludge Specific Gravity - 1
5. Application on farmland : $2m^3/ha$ =-d

Q. 23 Total voltage suspended solids to be anaerobically digested (kg/d VSS) shall be

(A) 133 (B) 168

(C) 233 (D) 245

Q. 24 Area requirements (ha) for disposal of the sludge on farmland shall be

(A) 2.95 (B) 1.95

(C) 0.95 (D) 0.55

Q. 25 For a two-dimensional irrotational flow, the velocity potential defined as $\phi = \log_e(x^2 + y^2)$. Which of the following is a possible stream function, y for this flow ?

(A) $\frac{1}{2}\tan^{-1}(y/x)$ (B) $\tan^{-1}(y/x)$

(C) $2\tan^{-1}(y/x)$ (D) $2\tan^{-1}(x/y)$

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Q. 26 A flat plate is kept in an infinite fluid medium. The fluid has a uniform free-stream velocity parallel to the plate, peak the correct matching List-I and List-II

	List-I		List-II
a.	Boundary layer thickness	1.	Decreases in the flow direction
b.	Shear stress at the plate	2.	Increases in the flow direction
c.	Pressure gradient along the plate	3.	Remains unchanged

Codes :

	a	b	c
(A)	1	2	3
(B)	2	2	2
(C)	1	1	2
(D)	2	1	3

Q. 27 A laboratory model of a river is built to a geometric scale of 1:100. The fluid used in the model oil of mass density 900 kg/m^3. The highest flood in the river is 10,000 m^3/s. The corresponding discharge in the model shall be

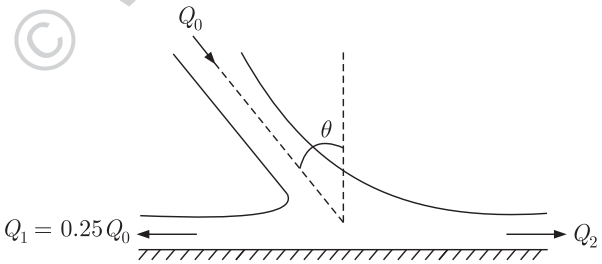
(A) 0.095 m^3/s

(B) 0.100 m^3/s

(C) 0.105 m^3/s

(D) 10.5 m^3/s

Q. 28 A horizontal jet strikes a frictionless vertical plate (the plan view is shown in the figure). It is then divided into two parts, as shown in the figure. If the impact loss is neglected, what is the value of θ ?



(A) 15°

(B) 30°

(C) 45°

(D) 60°

Q. 29 Two pipelines, one carrying oil (mass density 900 kg/m^3) and the other water, are connected to a manometer as shown in figure. By what amount the pressure in the water pipe should be increased so that the mercury levels in both the limbs of the manometer become equal ? (mass density of mercury= 13550 kg/m^3 and $g = 9.81$ m/s^2)

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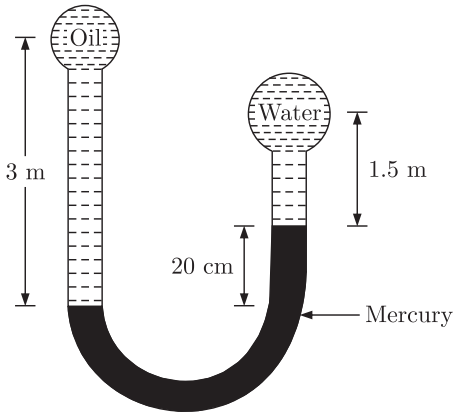
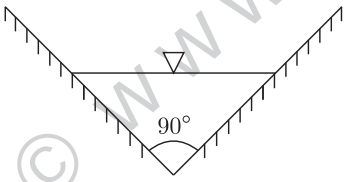


(A) 24.7 kPa
(B) 26.5 kPa
(C) 26.7 kPa
(D) 28.9 kPa

Q. 30 A solid sphere (diameter 6 mm) is rising through oil (mass density 900 kg/m^3, dynamic viscosity 0.7 kg/ms) at a constant velocity of 1 cm/s. What is the specific weight of the material form which the sphere is made ? (Take $g = 9.81$ m/s^2)

(A) 4.3 kN/m^3 (B) 5.3 kN/m^3
(C) 8.7 kN/m^3 (D) 12.3 kN/m^3

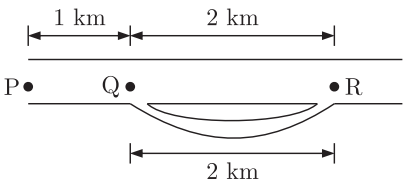
Q. 31 A hydraulic jump takes place in a triangular channel of vertex angle 90°, as shown in figure. The discharge is 1 m^3/s and the pre-jump depth is 0.5 m. What will be the post-jump depth ? (Take $g = 981$ m/s^2)



(A) 0.57 m (B) 0.91 m
(C) 1.02 m (D) 1.57 m

Common Data For Questions. 32 and 33 :

A pipeline (diameter 0.3 m, length 3 km) carries water form point P to point R (see figure). The piezometric heads at P and R are to be maintained at 100 m and 80 m, respectively. To increase the discharge, a second pipe is added in parallel to the existing pipe form Q and R. The length of the additional pipe is also 2 km. Assume the friction factor, $f = 0.04$ for all pipes and ignore minor losses.



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Q. 32 What is the increase in discharge if the additional pipe has same diameter (0.3 m) ?

(A) 0% (B) 33%

(C) 41% (D) 67%

Q. 33 If there is no restriction on the diameter of the additional pipe, what would be the maximum increase in discharge theoretically possible from this arrangement ?

(A) 0% (B) 50%

(C) 67% (D) 73%

Common Data For Questions. 34 and 35 :

A very wide rectangular channel carries a discharge of 8 m^3/s per m width. The channel has a bed slope of 0.004 and Manning's roughness coefficient, $n = 0.015$. At a certain section of the channel, the flow depth is 1 m.

Q. 34 What Gradually Varied Flow profile exists at this section ?

(A) M_2 (B) M_3

(C) S_2 (D) S_3

Q. 35 At what distance from this section the flow depth will be 0.9 m ?
(use the direct step method employing a single step.)

(A) 65 m downstream (B) 50 m downstream

(C) 50 m upstream (D) 65 m upstream

Q. 36 A masonry dam is founded on previous sand having porosity equal to 45% and specific gravity of sand particles is 2.65. For a desired factor of safety of 3 against sand boiling, the maximum permissible upward gradient will be

(A) 0.225 (B) 0.302

(C) 1.0 (D) None of these

Q. 37 Water is pumped from a well tapping an unconfined aquifer at a certain discharge rate and the steady state draw down (X) in an observation well is monitored. Subsequently, the pumping discharge is doubled and the steady state draw down in the same observation well is found to be more than double (i.e., more than 2X). This disproportionate draw down is caused by

(A) well losses

(B) decrease in the saturated thickness of the aquifer

(C) nonlinear flow

(D) delayed gravity yield

Q. 38 A double draining clay layer, 6 m thick, settles by 30 mm in three years under influence of certain loads. Its final consolidation settlement has been estimated to be 120 mm. If a thin layer of sand having negligible thickness is introduced at a depth of 1.5 m below the top surface, the final consolidation settlement of clay layer will be

(A) 60 mm (B) 120 mm

(C) 240 mm (D) None of these

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Q. 39 A 25 kN point load acts on the surface of an infinite elastic medium. The vertical pressure intensity in kN/m^2 at a point 6.0 m below and 4.0 m away from the load will be

(A) 132 (B) 13.2

(C) 1.32 (D) 0.132

Q. 40 A granular soil possesses saturated density of 20 kN/m^3. Its effective angle of internal friction is 35 degrees. If the desired factor of safety is 1.5, the safe angle of slope for this soil, when seepage occurs at and parallel to the slope surface, will be

(A) 25° (B) 23°

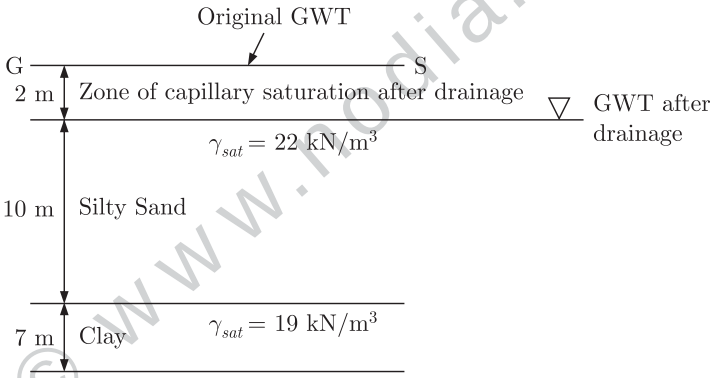
(C) 20° (D) 13°

Q. 41 In a plate test conducted on cohesion less soil, a 600 mm square test plate settles by 15 mm under a load intensity of 0.2 N/mm^2. All conditions remaining the same, settlement of a 1 m square footing will be

(A) less than 15 mm (B) greater than 25 mm

(C) 15.60 mm (D) 20.50 mm

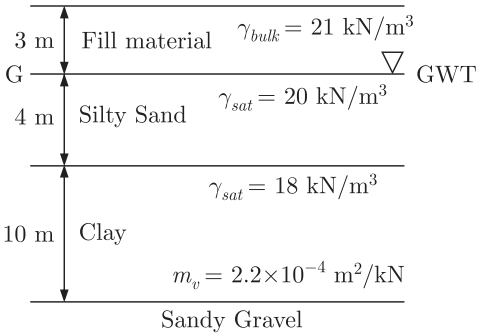
Q. 42 For the soil strata shown in figure, the water tables is lowered by drainage by 2 m and if the top 2 m thick silty sand stratum remains saturated by capillary action even after lowering of water table, the increase in effective vertical pressure in kPa at mid-height of clay layer will be



(A) 0.2 (B) 2

(C) 20 (D) 200

Q. 43 At a reclamation site for which the soil strata is shown in fig. a 3 m thick layer of a fill material is to be laid instantaneously on the top surface. If the coefficient of volume compressibility, m_v for clay is 2.2×10^{-4} m^2/kN, the consolidation settlement of the clay layer due to placing of fill material will be



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(A) 69.5 mm (B) 139 mm

(C) 228 mm (D) 278 mm

Q. 44 A braced cut 5 m wide and 7.5 m deep is proposed in a cohesionless soil deposit having effective cohesion $C' = 0$ and effective friction angle, $\phi' = 36^\circ$. The first row of struts is to be installed at a depth of 0.5 m below ground surface and spacing between the struts should be 1.5 m. If the horizontal spacing of struts is 3 m and unit weight of the deposit is 20 kN/m^2, the maximum strut load will be

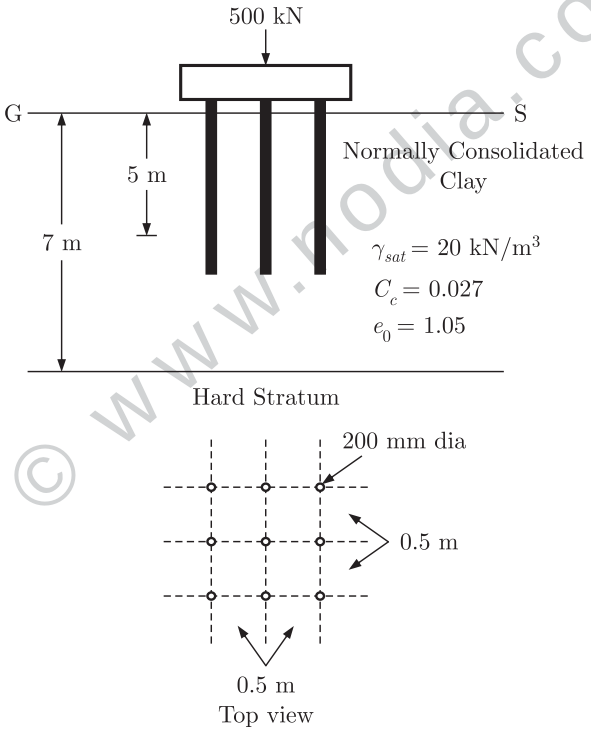
(A) 70.87 kN

(B) 98.72 kN

(C) 113.90 kN

(D) 151.86 kN

Q. 45 For the (3×3) pile group shown in the figure, the settlement of pile group, in a normally consolidated clay stratum having properties as shown in the figure, will be



(A) 13.2 mm (B) 12.775 mm

(C) 7.345 mm (D) None of these

Q. 46 Compaction of an embankment is carried out in 500 mm thick layers. The rammer used for compaction has a foot area of 0.05 m^2 and the energy imparted in every drop of rammer is 400 Nm. Assuming 50% more energy in each pass over the compacted area due to overlap, the number of passes required to develop compactive energy equivalent of Indian Standard light compaction for each layer would be

(A) 10 (B) 16

(C) 20 (D) 26

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Q. 47 Match the List I (Boring methods) with List II (Field conditions) and select the correct answer using the codes given below the lists :

	List I		List II
a.	Auger Boring	1.	Below water table in all soil types except hard soils and rocks
b.	Wash Boring	2.	Large diameter bore holes over 150 mm in size
c.	Percussion Drilling	3.	Exploration for shallow foundations and highways
d.	Rotary Drilling	4.	Bouldery and gravelly strata

Codes :

	a	b	c	d
(A)	3	1	4	2
(B)	1	2	4	3
(C)	2	3	4	1
(D)	3	1	2	4

Q. 48 Match the items of List I with List II and select the correct answer using the codes given below the lists :

	List I		List II
a.	Modulus of subgrade reaction	1.	Cyclic pile load test
b.	Relative density and strength	2.	Pressure meter test
c.	Skin friction and point bearing resistance	3.	Plate load test
d.	Elastic constants	4.	Standard penetration tests
		5.	Dynamic cone penetration test

Codes :

	a	b	c	d
(A)	1	3	2	5
(B)	1	2	4	3
(C)	2	5	1	3
(D)	3	4	1	2

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Common Data For Questions. 49 and 50 :

A canal having side slopes 1:1 is proposed to be constructed in a cohesive soil to a depth of 10 m below the ground surface. The soil properties are $\phi_u = 15^\circ, C_u = 12$ kPa, $e = 1.0, G_s = 2.65$.

Q. 49 If Taylor's Stability Number, S_n is 0.08 and if the canal flows full, the factor of safety with respect to cohesion against failure of the canal bank slopes will be

(A) 3.7

(B) 1.85

(C) 1.0

(D) None of these

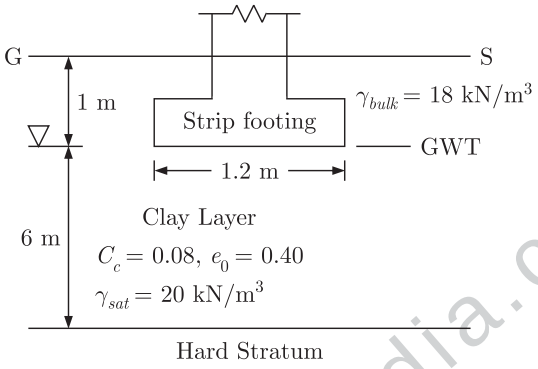
Q. 50 If there is a sudden draw down of water in the canal and if Taylor's Stability Number for the reduced value of ϕ_w is 0.126, the factor of safety with respect to cohesion against the failure of bank slopes will be

(A) 1.85 (B) 1.18

(C) 0.84 (D) 0.53

Common Data For Questions. 51 and 52 :

Figure shows the geometry of a strip footing supporting the load bearing walls of a three storied building and the properties of clay layer.



Q. 51 If the pressure acting on the footing is 40 kPa, the consolidation settlement of the footing will be

(A) 0.89 mm (B) 8.9 mm

(C) 89.0 mm (D) None of these

Q. 52 If the elastic modulus and the Poisson's ratio of the clay layer are respectively 50×10^3 kPa and 0.4 and if the influence factor for the strip footing is 1.75, the elastic settlement of the footing will be

(A) 0.41 mm (B) 1.41 mm

(C) 14.1 mm (D) None of these

Q. 53 Temperature stresses in concrete pavements may cause the slab to crack. If a slab cools uniformly then the crack will develop at the which of the following locations of the slab ?

(A) At centre (B) Near edges

(C) At corners (D) Near edges and at corners

Q. 54 The speed and delay studies on a defined section of highway are conducted by

(A) radar gun

(B) traffic counters

(C) moving car method

(D) enoscope

Q. 55 The design sped for a National Highway is 100 kmph. If the maximum permissible superelevation is 0.10 and the coefficient of lateral friction is 0.15, the ruling minimum radius of horizontal curve on the highway should be

(A) 260 m (B) 315 m

(C) 380 m (D) 410 m

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Q. 56 A traffic in a particular direction of a two lane roads is moving with a constant speed of 50 kmph, with an average headway of 2.52 seconds . The longitudinal distance between the two consecutive vehicles is

(A) 30 m (B) 35 m

(C) 38 m (D) 42 m

Q. 57 In the Marshall method of mix design, the coarse aggregates, fine aggregates, filler and bitumen, having respective specific gravities of 2.62, 2.72 and 1.02 are mixed in the ratio of 55, 34.6, 4.8 and 5.6 per cent, respectively. The theoretical specific gravity of the mix would be

(A) 2.36 (B) 2.40

(C) 2.44 (D) 2.50

Q. 58 The plate load test conducted with a 75 cm diameter plat on soil subgrade yielded a deflection of 2.5 mm under a stress of 800 N/cm^2. The modulus of elasticity of the subgrade soil, in kN/cm^2 is

(A) 141.6 (B) 154.6

(C) 160.0 (D) 185.4

Q. 59 List-I below gives a list of physical properties of aggregates which should be determined to judge their suitability in road construction. List-II gives a list of laboratory tests which are conducted to determine these properties. Match List-I with List-II and select the correct answer from the codes given below the lists :

	List-I		List-II
a.	Hardness	1.	Water adsorption
b.	Porosity	2.	Impact test
c.	Toughness	3.	Soundness test
d.	Durability	4.	Abrasion test

Codes :

	a	b	c	d
(A)	1	2	3	4
(B)	4	1	2	3
(C)	3	4	1	2
(D)	2	3	4	1

Q. 60 The vertical hydraulic conductivity of the top soil at certain stage is 0.2 cm/hr. A storm of intensity 0.5 cm/hr occurs over the soil for an indefinite period. Assuming the surfaces drainage to be adequate, the infiltration rate after the storm has lasted for a very long time, shall be

(A) smaller than 0.2 cm/hr (B) 0.2 cm/hr

(C) between 0.2 & 0.5 cm/hr (D) 0.5 cm/hr

Q. 61 The total irrigation depth of water, required by a certain crop in its entire growing period 150 days, is 25.92 cm. The culturable command are for a distributary channel is 100,000 hectares. The distributary channel shall be designed for a discharge

(A) less than 2 cumecs (B) 2 cumecs

(C) 20 cumes (D) more than 20 cumecs

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Q. 62 The moisture content of soil in the root zone of an agricultural crop at certain stage is found to be 0.05. The field capacity of the soil is 0.15. The root zone depth is 1.1 m. The consumptive use of crop at this stage is 2.5 mm/day and there is no precipitation during this period. Irrigation efficiency is 65%. It is intended to raise the moisture content to the field capacity in 8 days through irrigation. The necessary depth of irrigation is

(A) 115 mm (B) 169 mm

(C) 200 mm (D) 285 mm

Q. 63 While applying the Rational formula for computing the design discharge, the rainfall duration is stipulated as the time of concentration because

(A) this leads to the largest possible rainfall intensity

(B) this leads to the smallest possible rainfall intensity

(C) the time of concentration is the smallest rainfall duration for which the Rational formula is applicable

(D) the time of concentration is the largest rainfall duration for which the Rational formula is applicable

Q. 64 Match List-I with List-II and select the correct answers using the codes given below the lists :

	List-I		List-II
a.	Rainfall intensity	1.	Isohyets
b.	Rainfall excess	2.	Cumulative rainfall
c.	Rainfall averaging	3.	Hyetograph
d.	Mass curve	4.	Direct runoff hydrograph

Codes :

	a	b	c	d
(A)	1	3	2	4
(B)	3	4	1	2
(C)	1	2	4	3
(D)	3	4	2	1

Q. 65 While designing a hydraulic structure, the piezometric head at bottom of the floor is computed as 10 m The datum is 3m below floor bottom. The assured standing water depth above the floor is 2 m. The specific gravity of the floor material is 2.5. The floor thickness should be

(A) 2.00 m (B) 3.30 m

(C) 4.40 m (D) 6.00 m

Q. 66 The plan area of a reservoir is 1 km^2. The water level in the reservoir is observoir receives a surface inflow of 10 hectare-meters, and 20 hectare-meters are abstracted from the reservoir for irrigation and power. The plan evaporation and rainflow recorded during the same period at a nearby meteorolotical station are 12 cm and 3 cm respectively. The calibrated pan factor is 0.7. The seepage loss from the reservoir during the this period in hectare-meters is

(A) 0.0 (B) 1.0

(C) 2.4 (D) 4.6

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Common Data For Questions. 67 and 68

An average rainfall of 16 cm occurs over a catchment during a period of 12 hours with a uniform intensity. The unit hydrograph (unit depth = 1cm, duration = 6 hours) of the catchment rises linearly from 0 to 30 cumecs in six hours and then falls linearly from 30 to 0 cumecs in the next 12 hours ϕ index of the catchment is known to be 0.5 cm/hr. Base flow in the river is known to be 5 cumecs.

Q. 67 Peak discharge of the resulting direct runoff hydrograph shall be

(A) 150 cumecs (B) 225 cumecs

(C) 230 cumecs (D) 360 cumecs

Q. 68 Area of the catchment in hectares is

(A) 97.20 (B) 270

(C) 9720 (D) 27000

Q. 69 The effective length of a column in a reinforced concrete building frame, as per IS:456-2000, is independent of the

(A) frame type i.e. braced (no sway) or un-braced (with sway)

(B) span of the beam

(C) height of the column

(D) loads acting on the frame

Q. 70 Maximum strains in an extreme fibre in concrete and in the tension reinforcement (Fe-415 grade and $E_s = 200$ kN/mm^2) in a balanced section at limit state of flexure are respectively

(A) 0.0035 and 0.0038 (B) 0.002 and 0.0018

(C) 0.0035 and 0.0041 (D) 0.002 and 0.0031

Q. 71 The working stress method of design specifies the value of modular ratio, $m = 280/(3\sigma_{cbc})$, where σ_{cbc} is the allowable stress in bending compression in concrete. To what extent does the above value of 'm' make any allowance for the creep of concrete ?

(A) No compensation (B) Full compensation

(C) Partial compensation (D) The two are unrelated

Q. 72 List-I contain some properties of concrete/cement and List-II contain list of some tests on concrete/cement. Match the property with the corresponding test.

	List-I		List-II
a.	Workability of concrete	1.	Cylinder splitting test
b.	Direct tensile strength of concrete	2.	Vee-Bee test
c.	Bond between concrete and steel	3.	Surface area test
d.	Fineness of cement	4.	Fineness modulus test
		5.	Pull out test

Codes :

	a	b	c	d
(A)	2	1	5	3
(B)	4	5	1	3
(C)	2	1	5	4
(D)	2	5	1	4

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Q. 73 Top ring beam of an Intz tank carries a hoop tension of 120 kN. The beam cross-section is 250 mm deep and it is reinforced with 4 bars of 20 mm diameter of Fe-415 grade. Molular ratio of the concrete is 10. The tensile stress in N/mm^2 in the concrete is

(A) 1.02 (B) 1.07

(C) 1.20 (D) 1.32

Q. 74 A concrete column carries an axial load of 450 kN and a bending moment of 60 kNm at its base. An isolated footing of size 2 m $\times$ 3 m side along the plane of the bending moment, is provided under the column. Centres of gravity of column and footing coincide. The net maximum and the minimum pressures in kN/m^2 on soil under the footing are respectively,

(A) 95 and 55 (B) 95 and 75

(C) 75 and 55 (D) 75 and 75

Common Data For Questions. 75 and 76 :

A reinforced concrete beam, size 200 mm wide and 300 mm deep overall is simply supported over a span of 3 m. It is subjected to two point loads P of equal magnitude placed at middle third points. The two loads are gradually increased simultaneously. Beam is reinforced with 2 HYSD bars of 16 mm diameter placed at an effective cover of 40 mm on bottom face and nominal shear reinforcement. The characteristic compressive strength and the bending tensile strength of the concrete are 20.0 N/mm^2 and 2.2 N/mm^2 respectively.

Q. 75 Ignoring the presence of tension reinforcement, the value of load P in kN when the first flexure crack will develop in the beam is

(A) 4.5 (B) 5.0

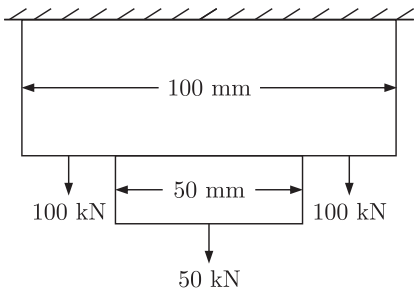
(C) 6.6 (D) 7.5

Q. 76 The theoretical failure load of the beam for attainment of limit state of collapse in flexure is

(A) 23.7 kN (B) 25.6 kN

(C) 28.7 kN (D) 31.6 kN

Q. 77 A bar of varying square cross-section is loaded symmetrically as shown in the figure. Loads shown are placed on one of the axes of symmetry of cross-section. Ignoring self weight, the maximum tensile stress in N/mm^2 anywhere is



(A) 16.0 (B) 20.0

(C) 25.0 (D) 30.0

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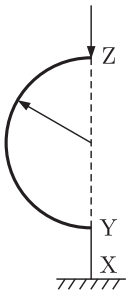
Q. 78 A curved member with a straight vertical leg is carrying a vertical load at Z, as shown in the figure. The stress resultants in the XY segment are



(A) bending moment, shear force and axial force

(B) bending moment and axial force only

(C) bending moment and shear force only

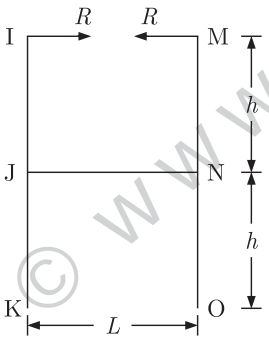
(D) axial force only

Q. 79 The state of two dimensional stresses acting on a concrete lamina consists of a direct tensile stress, $\sigma_x = 1.5$ N/mm^2, and shear stress, $\tau = 1.20$ N/mm^2, which cause cracking of concrete. Then the tensile strength of the concrete in N/mm^2 is

(A) 1.50 (B) 2.08

(C) 2.17 (D) 2.29

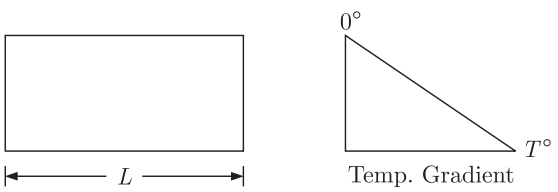
Q. 80 A "H" shaped frame of uniform flexural rigidity EI is located as shown in the figure. The relative outward displacement between points K and O is



(A) $\frac{RLh^2}{EI}$ (B) $\frac{RL^2h}{EI}$

(C) $\frac{RLh^2}{3EI}$ (D) $\frac{RL^2h}{3EI}$

Q. 81 A simply supported beam of uniform rectangular cross-section of width b and depth h is subjected to linear temperature gradient 0° at the top and T° at the bottom, as shown in the figure. The coefficient of linear expansion of the beam material is α. The resulting vertical deflection at the mid-span of the beam is



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(A) $\frac{\alpha T h^2}{8L}$ upward

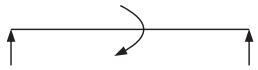
(B) $\frac{\alpha T L^2}{8h}$ upward

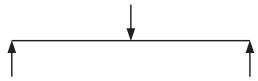
(C) $\frac{\alpha T h^2}{8L}$ downward

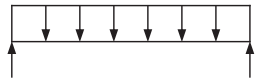
(D) $\frac{\alpha T L^2}{8h}$ downward

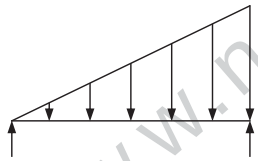
Q. 82 List I shows different loads acting on a beam and List II shows different bending moment distributions. Match the load with the corresponding bending moment diagram.

List I

(a) 

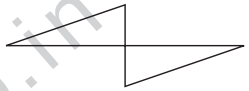
(b) 

(c) 

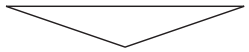
(d) 

List II

1.

2. 

3.

4. 

5.

Codes :

	a	b	c	d
(A)	4	2	1	3
(B)	5	4	1	3
(C)	2	5	3	1
(D)	2	4	1	3

Q. 83 A long structural column (length= L) with both ends hinged is acted upon by an axial compressive load, P. The differential equation governing the bending of column is given by :

$$EI\frac{d^2y}{dx^2} = -Py$$

Where y is the structural lateral deflection and EI is the flexural rigidity. The first critical load on column responsible for its buckling is given by

(A) $\frac{\pi^2 EI}{L^2}$

(B) $\frac{\sqrt{2}\,\pi^2 EI}{L^2}$

(C) $\frac{2\pi^2 EI}{L^2}$

(D) $\frac{4\pi^2 EI}{L^2}$

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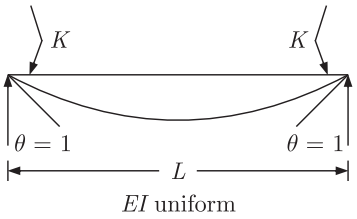
Q. 84 The stiffness K of a beam deflecting in a symmetric mode, as shown in the figure, is



(A) $\frac{EI}{L}$ (B) $\frac{2EI}{L}$

(C) $\frac{4EI}{L}$ (D) $\frac{6EI}{L}$

Q. 85 Muller Breslau principal in structural analysis is used for

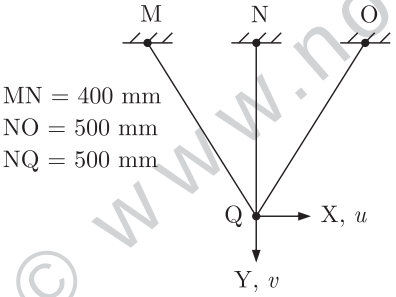
(A) drawing influence line diagram for any force function

(B) writing virtual work equation

(C) super position of load effects

(D) none of these

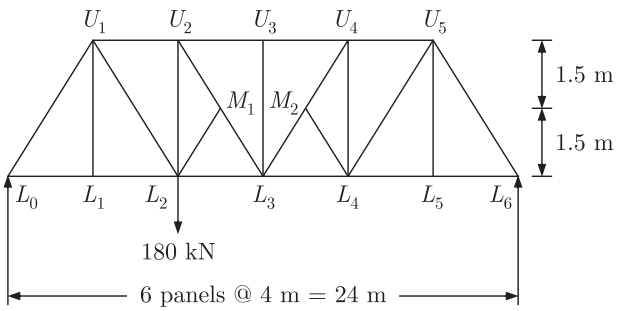
Q. 86 In a redundant joint model, three bar members are pin connected at Q as shown in the figure. Under some load placed at Q, the elongation of the members MQ and OQ are found to be 48 mm and 35 mm respectively. Then the horizontal displacement 'u' and the vertical displacement 'v' of the node Q, in mm, will be respectively,



(A) −6.64 and 56.14 (B) 6.64 and 56.14

(C) 0.0 and 59.41 (D) 59.41 and 0.0

Q. 87 A truss, as shown in the figure, is carrying 180 kN load at node L_2. The force in the diagonal member M_2U_4 will be



(A) 100 kN tension (B) 100 kN compression

(C) 80 kN tension (D) 80 kN compression

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Common Data For Questions. 88, 89 and 90 :

A beam PQRS is 18 m long and is simply at points Q and R 10 m apart. Overhangs PQ and RS are 3 m and 5 m respectively. A train of two point loads of 150 kN, 5 m apart, crosses this beam from left to right with 100 kN load leading.

Q. 88 The maximum sagging moment under the 150 kN load anywhere is

(A) 500 kNm (B) 450 kNm

(C) 400 kNm (D) 375 kNm

Q. 89 During the passage of the loads, the maximum and the minimum reactions at support R, in kN, are respectively

(A) 300 and -30 (B) 300 and -25

(C) 225 and -30 (D) 225 and -25

Q. 90 The maximum hogging moment in the beam anywhere is

(A) 300 kNm (B) 450 kNm

(C) 500 kNm (D) 750 kNm

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ANSWER KEY

2003									
1	2	3	4	5	6	7	8	9	10
(B)	(A)	(A)	(A)	(A)	(C)	(C)	(D)	(A)	(B)
11	12	13	14	15	16	17	18	19	20
(B)	(D)	(C)	(C)	(D)	(C)	(C)	(D)	(A)	(D)
21	22	23	24	25	26	27	28	29	30
(C)	(D)	(A)	(D)	(C)	(B)	(B)	(B)	(B)	(D)
31	32	33	34	35	36	37	38	39	40
(D)	(C)	(C)	(D)	(B)	(B)	(C)	(B)	(D)	(A)
41	42	43	44	45	46	47	48	49	50
(B)	(C)	(B)	(C)	(A)	(B)	(A)	(D)	(B)	(D)
51	52	53	54	55	56	57	58	59	60
(C)	(A)	(A)	(C)	(B)	(B)	(C)	(A)	(D)	(B)
61	62	63	64	65	66	67	68	69	70
(D)	(C)	(A)	(B)	(A)	(D)	(B)	(C)	(B)	(A)
71	72	73	74	75	76	77	78	79	80
(C)	(C)	(B)	(A)	(C)	(D)	(C)	(D)	(C)	(A)
81	82	83	84	85	86	87	88	89	90
(D)	(D)	(A)	(B)	(A)	(B)	(A)	(C)	(A)	(C)

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