

CCE(M)/CVL-I/10/2024

CIVIL ENGINEERING

(PAPER—I)

Time : 3 hours]

[Full Marks : 250

Please read each of the following instructions carefully before attempting the questions :

- (i) There are **eight** questions divided in **two Sections**.
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- (iii) Question Nos. **1** and **5** are compulsory and out of the remaining, **three** are to be attempted choosing at least **one** question from each Section.
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SECTION—A

1. Answer any five of the following questions :

10×5=50

- (a) From first principles, determine the following relationship between the three elastic constants E , K and G for an elastic material.

Where E = Young's modulus, K = Bulk modulus and G = Shear modulus.

- (b) Briefly discuss the advantages and disadvantages of steel as a structural building material.

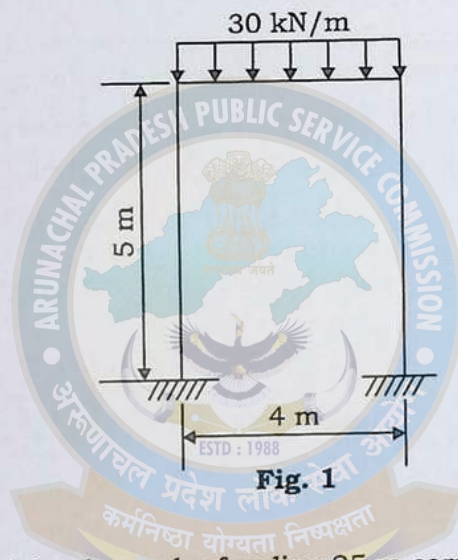
- (c) A fixed beam of span 6 m carries point loads of 150 kN and 200 kN at distances of 2 m and 4 m respectively from the left hand. Find out the fixed end moments and reactions at the support.

- (d) Design the longitudinal reinforcement of a reinforced concrete circular column having diameter 500 mm to carry an axial compressive load of 1600 kN. The column has an effective length of 3 m. Use M25 grade of concrete and Fe500 grade of steel.

- (e) Describe with neat sketches, the details of cantilever retaining wall and counterfort retaining wall constructed in reinforced concrete.
- (f) Calculate the product moment of inertia I_{xy} of an equal angles section ISA 50 mm $\times$ 50 mm $\times$ 10 mm size.
- (g) A steel shaft 5 mm in diameter turns at 10000 rpm. What is the maximum power that such a shaft may develop if the assigned working stress in shear is 350 kg/cm²?

2. Answer the following questions :

- (a) Analyse the portal frame shown in Fig.1 using moment distribution method and draw the bending moment diagram if all members have the same flexural rigidity.



- (b) A two-hinged semicircular arch of radius 25 m carries a uniformly distributed load of 30 kN/m on the entire span and a concentrated load of 500 kN at the crown. Calculate the support reactions. What will be the bending moment at the Crown Point?
- (c) Calculate the collapse load for a propped cantilever of span "L" subjected to a uniformly distributed load of " w " per unit length.

3. Answer the following questions :

- (a) A simply supported beam of 6 m span is subjected to a concentrated load of 20 kN at 2 m from the left support. Calculate the slope and deflection under the load point of the beam. Also calculate the maximum deflection occurring in the beam and its location. ($EI = 15 \times 10^9$ kN-mm²)
- (b) Describe with neat sketches the various types of welded joints used in structural steel work. Also discuss the merits and demerits of welded joint versus bolted joint.

- (c) A reinforced concrete beam of size 300 mm × 500 mm is reinforced with 3 nos. 16 mm dia. bars as tension enforcement. Nominal concrete cover is 30 mm and diameter of stirrup bars is 8 mm. Using Limit State Method of design, calculate the moment of resistance of beam section. Use M25 grade of concrete and Fe500 grade of Steel.

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4. Answer the following questions :

- (a) A cantilever retaining wall is constructed to retain horizontal earthen embankment of height 3.0 m above the ground level as per the profile shown in Fig.2. The earthen backfill is having density of 16 kN/m^3 and angle of internal friction 25° . The coefficient of friction between soil and concrete is assumed to be 0.4. The water table is at ground level. Find out the bearing pressure developed on the soil and factor of safety against overturning and sliding.

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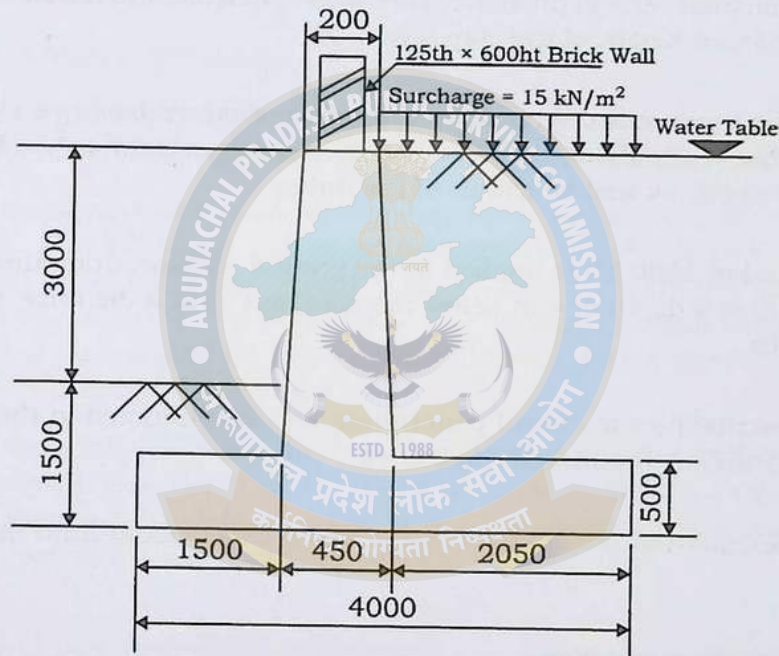


Fig.2

- (b) A hollow cast iron column whose outside diameter is 200 mm and wall thickness 20 mm is 4 m long and fixed at both ends. Calculate the safe load by Rankine's formula using a factor of safety of 2.5. Also find the ratio of Euler's load to Rankine's load. $E = 1 \times 10^5 \text{ N/mm}^2$ and Rankine's constant = $1/1600$ and $f_c = 550 \text{ N/mm}^2$.
- (c) A reinforced concrete column of size 400 mm × 400 mm is to transfer an axial compressive load of 1000 kN to a soil having safe bearing capacity of 150 kN/m^2 . Proportion the size of a rectangular footing given that the maximum width allowed is 2.5 m. Also calculate the bending moment, one-way shear and two-way shear in the critical sections for design along both the directions of the footing. The footing slab is of a uniform thickness having an effective depth of 500 mm.

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SECTION—B

5. Answer any **five** of the following questions :

10×5=50

- (a) Briefly discuss the various processes of soil stabilization by use of admixture.
- (b) What is meant by turbine? Draw a comparison between reaction turbine and impulse turbine.
- (c) A clay layer of 3.5 m thick rests beneath a deposit of submerged sand of 7.8 m thick. The top of the sand is located 3.2 m below the surface of a lake. The saturated unit weight of the sand is 19.6 kN/m^3 and of the clay is 18.4 kN/m^3 . Find out the total vertical pressure, pore water pressure and the effective vertical pressure at mid height of the clay layer.
- (d) A hydraulic jump occurs in a wide rectangular channel having a slope of 0.20. The effective depth of flow is 0.3 m and the discharge is $2.5 \text{ m}^3/\text{s}$. Find out the conjugate depth as well as length of the jump.
- (e) A point load of 1200 kN is applied at the ground surface. Compute the vertical pressure (i) at a depth of 4 m below the load and (ii) at a distance of 3 m at the same depth.
- (f) Briefly describe how standard penetration test is conducted in the field as per Bureau of Indian Standards guidelines.
- (g) Derive the equation of continuity for a three-dimensional fluid flow.

6. Answer the following questions :

- (a) A particular soil sample failed under the major principal stress of 600 kN/m^2 with a corresponding minor principal stress of 200 kN/m^2 . If for the same soil the minor principal stress had been 300 kN/m^2 , determine what the major principal stress would have been if (i) $\phi = 35$ degrees and (ii) $\phi = 0$. 20
- (b) A trapezoidal plate having its sides $2a$ and a length are at a distance h apart. The plate is immersed vertically in water at a depth of h below the water surface. Find out the thrust on the plate and centre of pressure. 15
- (c) Explain with sketch the Terzaghi's method of determining bearing capacity of soil. 15

7. Answer the following questions :

- (a) What do you understand by dimensional analysis? The discharge Q over a weir per unit length depends upon the head H of water over the weir, the height P of the weir and the acceleration due to gravity g . Perform a dimensional analysis to obtain an expression for the discharge. 20
- (b) A soil sample in its natural state has a mass of 2.29 kg and a volume of $1.15 \times 10^{-3} \text{ m}^3$. Under an oven dried state, the dry mass of the sample is 2.035 kg. The specific gravity of the solids is 2.65. Determine the total density, water content, void ratio, porosity and degree of saturation and the air void ratio. 15
- (c) Explain the concept of boundary layer flow. What are the various laws assumed for velocity distribution in laminar boundary layer? 15

8. Answer the following questions :

- (a) Describe in detail how the capacity of piles is estimated in cohesive and cohesionless soil under (i) compressive load, (ii) uplift load and (iii) lateral loads. 20
- (b) A stratum of normally consolidated clay of thickness 3 m is drained on one side only. The soil has a hydraulic conductivity of $k = 5 \times 10^{-8} \text{ cm/sec}$ and a coefficient of volume compressibility $m_v = 125 \times 10^{-2} \text{ cm}^2/\text{sec}$. Determine the ultimate value of the compression of the stratum by assuming a uniformly distributed load of 250 kN/m^2 on the soil. Also, determine the time required for 20% and 80% consolidation. 15
- (c) What is meant by the term "the most economical channel section"? A channel of section with side slopes at 45° to the horizontal conveys water at a depth of 0.75 m. Find out the width of the base and the gradient of the bed to discharge $1.25 \text{ m}^3/\text{sec}$ with a mean velocity of 0.8 m/sec . ($C = 65$) 15

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SPACE FOR ROUGH WORK



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CIVIL ENGINEERING

(PAPER—II)

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SECTION—A

ESTD : 1988

1. Answer any five of the following questions :

10×5=50

- (a) Write a note on various types of cement available for construction purpose. List various chemical constituents of Portland cement. What is Bogue's compound?
- (b) Explain a method of providing waterproof terracing on RCC roof slab.
- (c) A traverse is done through three stations A, B and C in clockwise order in the form of an equilateral triangle. If the bearing of AB is $82^{\circ}30'$, find out the bearings of the other two sides.
- (d) Differentiate clearly between PERT and CPM network methods.
- (e) Design a flexible pavement for a four-lane divided carriageway to be constructed on a subgrade with CBR of 4%. Consider the following data for design :

Design life = 20 years

Traffic (both way) in the year project to be completed = 4000 cvpd

Annual growth rate of commercial vehicles = 6%

VDF (vehicle damage factor) = 5%

(f) What are meant by earthquake resistant buildings? Write briefly on various clauses prescribed by Bureau of Indian Standards for design of earthquake resistant buildings.

(g) What is the necessity of points and crossing on Railways? Draw a double line sketch of a right-hand turnout and name its different parts.

2. Answer the following questions :

(a) While aligning a Highway in a built-up area it is required to provide a horizontal circular curve of radius 325 m. Design the following geometry features :

(i) Super elevation, (ii) Extra widening of pavement and (iii) Length of transition curve

The following data are available :

Design speed = 65 kmph

Length of wheel base of largest truck = 6 m

Pavement width = 10.5 m

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(b) Describe in detail the various temporary adjustments required during the setup of a levelling instrument. Also, explain the various corrections that are to be applied during a levelling operation.

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(c) The details of a network are given below and the duration is in days. Draw the project network and identify the critical path. Calculate float for each activity and identify the project duration.

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Activity	t_o	t_m	t_p
1-2	2	5	8
1-3	1	4	7
2-3	0	0	0
2-4	2	4	6
2-6	5	7	9
3-4	3	5	7
3-5	3	6	9
4-5	4	6	9
4-6	2	5	8
5-6	2	4	6

3. Answer the following questions :

(a) List various criteria for site distance requirements on highway. The speeds of overtaking and overtaken vehicles are 70 kmph and 40 kmph respectively on a two-way traffic road. If the acceleration of overtaking vehicle is 0.99 m/sec, then

- (i) calculate the safe overtaking sight distance;
- (ii) calculate the minimum length of overtaking zone;
- (iii) draw a neat sketch of the overtaking zone and also show the position of the signposts.

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(b) The following observations were made during the testing of a dumpy level :

Instrument at	Staff reading on (m)		Remark
	A	B	
A	1.725	2.245	R.L of A = 450.000 m
B	2.145	3.045	

Distance between A and B = 200 m.

Is the instrument in adjustment? To what reading the line of collimation should be adjusted when the instrument is at B?

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(c) What is high strength concrete? How is it different from standard concrete? Briefly explain the procedure for concrete mix proportioning as per BIS code.

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4. Answer the following questions :

(a) An incomplete traverse table is obtained as follows :

Line	Length (m)	Bearing
AB	100.0	??
BC	80.5	140°30'
CD	60.0	220°30'
DA	???	310°15'

Calculate the length of DA and bearing of AB.

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- (b) The consolidated data collected from speed and delay studies by floating car method on a stretch of an urban road of length 2.5 km, running East-West are given below in the Table. Determine the average values of volume, journey speed and running speed of the traffic stream along either direction.

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Direction	Mean journey times (minutes)	Mean stopped delay (minutes)	Number of vehicles (Mean value)		
			Overtaking	Overtaken	In opposite direction
East-West	4.85	1.60	4.5	6.5	376
West-East	8.36	1.90	4.0	5.5	280

- (c) What are the differences between flexible and rigid pavements? Draw a neat sketch of a flexible pavement cross-section and show the various component parts. Describe the functions and importance of each component of the pavement.

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SECTION—B

5. Answer **any five** of the following questions :

10×5=50

- (a) Explain Duty and Delta. What is the discharge capacity required for the outlet to irrigate 2200 ha of sugarcane having a “kor depth” of 17 cm and a “kor period” of 30 days?
- (b) Design an earthen Canal using Lacey’s silt theory with the following data :
Full supply discharge, $Q = 15 \text{ m}^3/\text{sec}$
Lacey’s silt factor = 1.0
Canal side slope = 0.5 H : 1 V
- (c) What are spillways? Describe their function. List the various types of spillways.
- (d) Discuss the factors which should be considered during design and operation of a sanitary landfill site for disposal of municipal solid waste.
- (e) The maximum daily demand at a water purification plant has been estimated as 12 million litres per day. Design the dimensions of a suitable sedimentation tank (fitted with mechanical sludge removal arrangement) for the raw supplies. Assuming a detention period of 6 hours and the velocity of flow as 20 cm per minute.
- (f) What is the effect of the substances like fluoride, nitrate, nitride, chloride and arsenic in potable water if they exceed their permissible limits? Also mention the permissible limits for the same.
- (g) Define ‘pH’ of a water sample. Two water samples were collected and then mixed together. Sample A has pH 8 with volume 600 ml while sample B has pH 6 with volume 400 ml. Find out the pH of the mixture.

6. Answer the following questions :

(a) Explain in detail the following terms :

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(i) Evaporation

(ii) Transpiration

(iii) Evapotranspiration

(iv) Infiltration

(b) A catchment has five rain gauge stations. In a year, the annual rainfalls recorded by the rain gauges are 723 mm, 864 mm, 942 mm, 1038 mm and 714 mm respectively. For a 5% error in the estimation of the mean rainfall, find out the additional number of rain gauges needed.

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(c) What do you understand by 'per capita demand' of water and how is it determined? If average daily water demand is 135 litres per capita per day, determine the following :

(i) Maximum daily demand of water

(ii) Maximum weekly demand of water

(iii) Maximum monthly demand of water

(iv) Maximum hourly demand of water

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7. Answer the following questions :

(a) What is an aquifer? Deduce the expression for discharge through a well in an unconfined aquifer. If the permeability of an aquifer, $k = 10^{-4}$ m/s, radius of the drawdown curve, $R = 500$ m, radius of well = 5.0 m, thickness of unconfined aquifer, $H = 30$ m and after drawdown depth of water in well, $h = 10$ m, find out the steady discharge per day.

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(b) What is the function of a settling tank? The sewage flows from a primary settling tank to a standard rate trickling filter at a rate of 5 million litres per day having BOD of 100 mg/litre. Determine the depth and volume of the filter, adopting a surface loading of 2500 litres/m²/day and an organic loading of 165 g/m³/day. Also, determine the efficiency of the filter unit using the NRC formula.

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(c) Explain with the help of a diagram various component parts along with the functions of a diversion head work.

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8. Answer the following questions :

- (a) Define a hydrograph. The inflow hydrograph of a river at a section is given below :

Assuming travel time, $k = 8$ hours, weighting factor, $x = 0.15$ and time interval, $\Delta t = 6$ hours, route the hydrograph using Muskingum method. Determine the lag in peak and flow attenuation.

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Time(h)	0	6	12	18	24	30	36	42	48	54	60	66
Inflow (m ³ /sec)	20	80	210	240	215	170	130	90	60	40	28	20

- (b) What are the various types of dams constructed on rivers? Elaborate the principles of stability analysis of a solid gravity dam.

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- (c) Design a standard egg-shaped sewer pipe section for a combined storm water sewage flow for a residential Colony with the following data :

- (i) Area of Colony = 30 hectares
- (ii) Population = 20000
- (iii) Per capita water consumption = 200 lphd
- (iv) Critical design rainfall intensity = 40 mm/hour
- (v) General available ground slope = 1 in 900
- (vi) Runoff coefficient for the area = 0.55
- (vii) Manning's coefficient for the pipe = 0.013

Assume 80% of water consumed to appear as sewage. Also, peak sewage discharge equals to three times the average discharge.

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