C.S.E. (MAIN)

CIVIL ENGINEERING

PAPER – I – 2004

Time Allowed : Three Hours *Maximum Marks : 300*

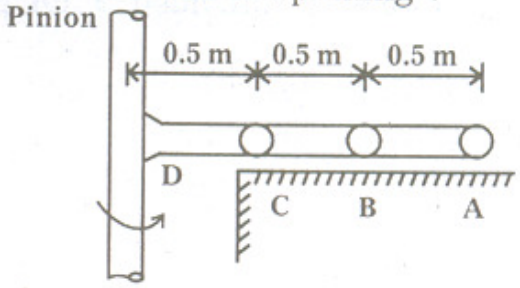
Candidates should attempt Questions 1 and 5 which are compulsory and any **three** of the remaining questions selecting at least **one** question from each Section.

If any data is considered insufficient, assume suitable value and indicate the same clearly. Newton may be converted to kg using the equality 1 kilonewton (1 kN) = 100 kg, if found necessary.

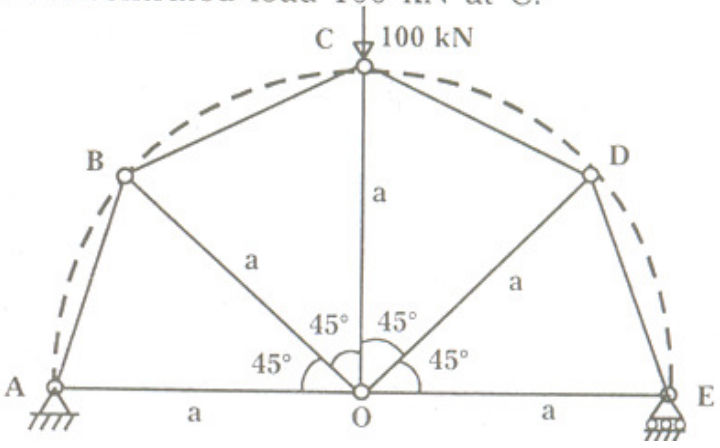
SECTION 'A'

1. Attempt any **five** parts of the following :

(a) Three 5 kg masses attached to a light rod ABCD are spun on a frictionless horizontal plane at 600 rpm (10 Hz) about a pinion. What is the maximum force induced in the rod due to spinning ? 12



(b) Find forces in all members of the truss shown, due to a concentrated load 100 kN at C. 12



OA = OB = OC = OD = OE = a

AB = BC = CD = DE **12**

(c) What are the strength theories for yielding and fracture of materials ? State the theory more suited for (i) mild steel, (ii) concrete. **12**

(d) Find the discharge of water through a horizontal venturimeter having 400 mm diameter at the inlet main and 150 mm diameter at the throat, if the differential gauge between the inlet and its throat shows a pressure head of 25 cm of mercury. Assume coefficient of discharge for the meter as 0.98 and the specific gravity of mercury as 13.6 **12**

(e) The water is flowing with a velocity of 1.5 m/s in a pipe of length 2500 m and diameter 500 mm. At the end of the pipe a valve is provided. Find the rise in pressure

(i) if the valve is closed in 5 seconds.

(ii) if the valve is closed instantaneously. **12**

Take value of C = 1460 m/s, pipe to be rigid and bulk modulus of water = 19.62×10^4 N/cm^2.

(f) Explain (i) Boundary layer thickness, and

(ii) Displacement thickness.

The velocity distribution in a laminar boundary layer is given by

$$\frac{u}{U} = 3\left(\frac{y}{\delta}\right) - 2\left(\frac{y}{\delta}\right)^2$$

where u is the velocity at a distance y from the plate, δ is the boundary layer thickness and U is the free stream velocity.

Find the ratio of displacement thickness to boundary layer thickness. **12**

2. (a) A solid steel rod of length 2 m diameter 20 mm vertically hangs from the ceiling and has a collar firmly attached to it. Above the collar an annular rubber

washer of 40 mm thickness having a stiffness k = 5 N/mm is placed. Determine maximum stress in the rod caused by a mass of 5 kg falling through a height of 1.2 m. **20**

(b) A beam of uniform cross-section resting on two supports 'b' m apart has an equal overhang of 'a' m on either end. Determine the ratio of b/a when the magnitude of mid span bending moment is equal to the magnitude of support bending moment due to its own weight. For this condition, draw the bending moment diagram, locate contraflexure points. **20**

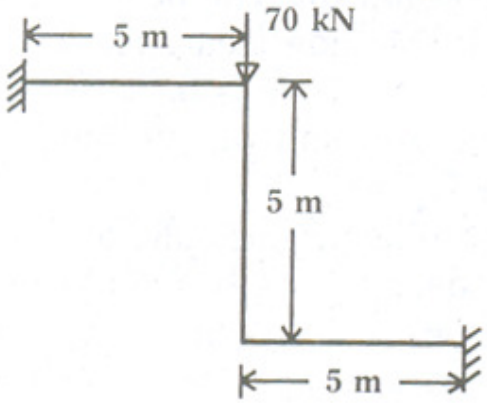
(c) A Pelton wheel has a mean bucket diameter of 1 m and is running at 1000 rpm. The net head on the Pelton wheel is 700 m. If the side clearance angle is 15° and discharge through the nozzle is 0.1 m^3/s, find (i) power available at the nozzle, and (ii) hydraulic efficiency of the turbine. Take $C_v = 1$. **20**

3. (a) A three hinged parabolic arch of span 60 m and rise 15 m has been loaded by a uniformly distributed load of 30 kN/m over the left half of the span. Calculate moment, shear force and axial thrust on a point situated at a section 15 m from the left support. **20**

(b) A river stretch 10 km long and 920 m wide is to be modelled for flood studies in a hydraulic laboratory where the available flume size is 2 m width, 20 m length and 70 cm height. It is decided to use a depth scale of 10. If the peak flood in the river is 3000 cumec at a depth of 6 m, find the suitable horizontal scale to be adopted for construction of the model. Maximum available flow is 150 litres/s in the laboratory. The horizontal scale should be a multiple of 10 and such that the model is as big as possible. Determine the model dimensions, depth and discharge. Assume the hydraulic depth is same as the depth of flow in both the model and the prototype. **20**

(c) A centrifugal pump has an impeller of 0.5 m outer diameter and when running at 600 rpm discharges at the rate of 8000 litres/minute against a head of 8.5 m. The water enters the impeller without whirl and shock. The inner diameter is 0.25 m and the vanes are set back at the outlet at an angle of 45° and the area of flow which is constant from inlet to outlet of the impeller is 0.06 m^2. Determine (i) manometric efficiency of the pump, (ii) the vane angle at inlet, and (iii) the least speed at which the pump commences to work. **20**

4. (a) Analyse the frame shown in the figure by Moment distribution method and draw bending moment diagram. EI for all members are equal. **20**



(b) A Warren girder of 25 m span has six panels of 5 m each with all triangles being equilateral. Draw influence line for the bottom chord member in the second panel from the left due to uniform dead load of 10 kN/m and live load of 20 kN/m, longer than the span. **20**

(c) An unlined canal has its bed and side slopes composed material having mean diameter of particles 6 mm. Angle of repose of the material is 40°, the bed width of the canal is 5 m and the side slopes 1.5 (H) : 1 (V). Determine the minimum discharge that can be admitted into the canal without any sediment movement. Take bed slope 1 in 5000 and Manning's n = 0.025. **20**

SECTION B

5. Attempt any **five** parts from the following :

(a) A tension member is of pair of equal angles ISA 65 × 65 × 6 placed back to back on either side of gusset plate 10 mm thick. Calculate maximum pull resisted by the member. Design the welded connection with the Gusset plate. f_y = 250 MPa. 12

(b) A reinforced concrete beam of rectangular cross-section 230 mm × 450 mm has a clear cover to reinforcement of 30 mm. At the support the tension reinforcement is of 3 numbers of 20 mm diameter Fe 415 steel rods. The support transfers a factor of shear force of 110 kN to the beam. Design the spacing of two legged 8 mm stirrups. For concrete grade M 20 T_c values are tabulated 12

$\frac{100A_s}{bd}$	0.75	1.00	1.25
T_c (MPa)	0.56	0.62	0.67

(c) Explain the reasons for the following : 12

(i) Ordinary mild steel cannot be used for prestressed wires.

(ii) Loss due to elastic shortening in post-tensioned beam is less than that in pre-tensioned beam.

(iii) Deflection of prestressed beams with tendons provided as a parabolic profile compensates part of dead load deflections.

(d) During a compaction test a soil attains the maximum dry density of 18.6 kN/m³ at a water content of 15 percent. The specific gravity of soil is 2.7. Determine the degree of saturation, air content and percentage of air voids at the maximum dry density. What would be the maximum theoretical dry density corresponding to zero

air voids at optimum water content. 12

(e) A canal 6 m deep runs through a soil having C_u = 18 kN/m², ϕ_u = 10°, e = 0.8 and G = 2.72. The angle of slope of a bank is 45°. Determine the factor of safety with respect to cohesion when the canal is full upto the top of the banks. If the sudden drawdown takes place upto the bed level of the canal, what will be the factor of safety ?

For β = angle of slope of bank = 45° ;

ϕ_u = 10° Stability number = 0.108

ϕ_u = 4.88° Stability number = 0.137 12

(f) A settlement analysis carried out for a proposed structure indicates that 5 cm of settlement will occur in 5 years and that the final settlement will be 25 cm. The computation was made on the basis of double drainage condition. However, subsequent borings established only single drainage condition. Calculate the final settlement and the settlement in 5 years for the changed condition. 12

6. (a) A stratum of saturated clay (G = 2.7) has an initial water content of 44 percent throughout its depth. After a long dry spell, the water content at the ground surface is 20 percent and at a depth of 3 m, the water content is 44 percent. The water content may be taken to vary linearly with depth. The shrinkage limit of the clay is 28 percent. If the change in height per unit height of the clay ($\Delta H/H$) is 80 percent of its change in volume per unit volume ($\Delta V/V_0$), what is the amount of settlement of the ground surface due to change in water content which occurred ? 20

(b) (i) A loading of 50 kN/m² is acting on an annular foundation of width 5 m and inside diameter of 10 m. Find the vertical stress intensity at a depth of 10 m be-

low the centre of the foundation.

(ii) In a direct shear test on clean dry sand, failure occurred at a shear stress of 30 kN/m² when the normal stress was 50 kN/m². Draw the Mohr's stress circle and find the angle of internal friction. Determine the magnitudes of principal stresses and the orientation of principal planes with respect to plane of shearing. **12+8=20**

(c) A built-up laced column of overall square cross-section, 300 mm side has been formed by placing four angles of ISA 50×50×6 at the corners of the square. If the effective height of column is 10 m, calculate the load carrying capacity of the column. Also design lacings.

l/r	40	50	60	70	80	90	100	145
σ_{ac} (MPa)	164	153	139	125	111	98	86	50

For ISA 50×50×6, Area = 568 mm²,

$I_x = I_y = 11 \times 10^4$, $C_y = 14.5$ mm. **20**

7. (a) (i) What is SPT ? How is the SPT value obtained and corrected ?

(ii) What will be the safe load carrying capacity for a strip footing 2 m wide with a factor of safety of 3 ? The footing is located in a cohesive soil with c = 60 kN/m² and $\phi = 5°$ at a depth of 1.5 m below G.L. The soil has specific gravity of 2.7 and void ratio of 0.7. Take water table at ground surface and the bearing capacity factors for $\phi = 5°$ as $N_c = 7$, $N_q = 2$ and $N_\gamma = 1$. **5+15=20**

(b) (i) Differentiate between 'state of elastic equilibrium' and 'state of plastic equilibrium' of soil mass. Show them by drawing Mohr's circle and envelope. Show the state of equilibrium for active, passive and at rest conditions. What will be the active and passive pressures in a fluid with density 20 kN/m³ at a depth of 2 m ?

(ii) A cut 10 m deep is excavated in sand ($\phi = 30°$ and $\gamma = 17$ kN/m^3) and is to be braced by sheeting and bracing system. The top strut will be at 0.5 m below G.L. followed by subsequent struts at every 1.5 m centre to centre in vertical direction. The spacing of struts along the cut is 3 m centre to centre. Compute the top, middle and bottom strut loads. **10 + 10 = 20**

(c) Design a reinforced concrete floor slab for a residential building for the following particulars, adopting limit state method of design.

Clear dimensions of room : 3 m × 8 m

Wall thickness : 230 mm

Live load on floor : 2 kN/sq. m

Finishes : 1 kN/sq. m

Concrete : M 20

Steel : Fe 415

Minimum total depth of slab : 125 mm **20**

8. **(a)** A combined rectangular footing for supporting two reinforced columns A and B has to be designed. Particulars of the columns are as follows :

Column	Size (mm)	Position	Working Load (kN)
A	350 × 350	Outer face at boundary	1000 kN
B	450 × 450	3 m from centre of column A	2400 kN

Safe bearing capacity of soil : 300 kN/sq. m

Obtain plan dimensions of footing. Draw shear force and bending moment diagrams of the footing. **20**

(b) A trapezoidal masonry retaining wall 6 m high and

1.2 m wide at top retains earth of unit weight 16 kN/m³, $\phi = 35°$ to the top of the wall on the vertical face. Calculate the minimum bottom width necessary so that no tension occurs at the base. Density of masonry : 20 kN/m³. **20**

(c) (i) List the criteria laid down by IS 2911 for assessing the allowable load on a single pile from the results of a routine pile load test.

(ii) A column carrying a load of 1000 kN is to be supported on a group of piles having 30 cm diameter and 10 m length. The soil is clay having unconfined compressive strength of 100 kN/m². Compute the number of piles required for bearing capacity considerations. Also check for the group capacity if the spacing is two times the diameter of the pile. Take : m = 0.7 and factor of safety of 3. **4 + 16 = 20**

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PAPER – II – 2004

Time Allowed : Three Hours *Maximum Marks : 300*

Candidates should attempt Questions 1 and 5 which are compulsory and any **three** of the remaining questions selecting at least **one** question from each Section.

Notations/terms used have their usual meanings.

If any data is considered insufficient, assume suitable value and indicate the same clearly.

Provide diagrams in the answer books, wherever necessary.

SECTION 'A'

1. Answer any **five** of the following :

(a) Consider an initial investment P, depreciated in equal annual instalments to a salvage value L at the end of n years; and consider the average annual interest rate to be i. Determine the equivalent annual cost by this depreciation taken with the average interest. **12**

(b) Materials required per cu.m. of freshly mixed cement concrete are : 312 kg of dry cement, 855 kg of sand, 1010 kg of gravel and 145 kg of fresh water. Bulking, when mixing in the mixer, is 5%. What would be the density of the freshly mixed and poured cement concrete ? What would be the total volume of fresh concrete that can be produced in a nominal 6 cu.m. mixer, in which loading during mixing can be only 65% of nominal capacity, per hour if its working cycle is : charging – 35 seconds, mixing – 170 seconds, discharging – 30 seconds and lost time – 18 seconds. **12**

(c) What are the several activities that can be taken as protective and restorative measures as part of post-construction termite-proofing ? **12**

(d) Describe the common mistakes in linear measurements using chains and the measures to be adopted to eliminate these mistakes. 12

(e) Enumerate the major policies and objectives of the Third Twenty-Year Road Development Plan (1981-2001) of India. 12

(f) How are speed, travel time, volume and density of traffic on a road mutually related ? Illustrate with sketches as appropriate. 12

2. (a) Insulation for thermal lagging on steam pipes laid for central heating is available in several (alternative) thicknesses. Corresponding total initial costs of providing the insulation and the yet-persisting annual heat loss throughout the ducting are tabulated. The service life is expected to be 7 years. Adopting MARR of 8%, evaluate the optimum thickness to be adopted, through incremental annual cost (or benefit) analysis. 20

(b) Describe in sequential detail the operations involved in laying and finishing Terrazzo flooring of 40 mm thickness. 20

(c) What are the functions of a marshalling yard ? List the factors to be considered in developing an efficient marshalling yard. 20

3. (a) To implement a particular job segment within its line of business, a firm can purchase either equipment 'A' or equipment 'B'. 'A' has a first cost of 2000 units and involves an annual operating cost of 1700 units over its useful life of 5 years. 'B' has a first cost of 3400 units and involves an annual operating cost of 1500 units over its useful life of 8 years. What is the rate of return at which the firm can be indifferent between 'A' and 'B' ? 20

(b) (i) Describe the methods commonly adopted to

check the accuracy of an open traverse. **10**

(ii) List the major disadvantages of Plane Tabling. **10**

(c) Explain, with sketches, the commonly adopted sub-surface drainage systems provided in national highways to lower the water table and to control seepage. **20**

4. (a) Cash flow for a simple project is given herewith. Taking a first trial value of 15%, determine the rate of return to the first decimal place of a per cent.

EoY	0	1	2	3	4	5	6
Cash Flow	-15	-10.5	+6	+9	+12	+8	+6

20

(b) (i) Describe the several stages of observation, recording and computation through which activity time rating is arrived at through concepts of time and motion study. **10**

(ii) Describe, along with their functions, the major types of road markings commonly used in India. **10**

(c) Compare the capabilities of terrain features interpretation through aerial photographs vis-a-vis topographic maps. **20**

SECTION 'B'

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

(a) Why are canal falls provided in irrigation channels ? With the help of sketches, describe and illustrate a trapezoidal notch fall, labelling all the salient features and their functions in flow management and safety. **12**

(b) What is meant by river training ? What are its objectives ? What are the in-situ features that help in this context ? **12**

(c) Estimate the depth and frequency of irrigation

required for a certain crop, given :

Root zone depth	:	90 cm
Field capacity	:	22%
Wilting point	:	12%
Apparent sp. gr. of soil	:	1.5
Consumptive use	:	22 mm/day
Efficiency of irrigation	:	60%

Assume 50% depletion of available moisture as the indicator to begin application of irrigation water. **12**

(d) List the tests to be performed to determine impurities in water. In this context, explain the terms "Hardness" and "pH" of water – in terms of causes, classification as appropriate, and effects due to consumption and the tests relevant therein. **12**

(e) What considerations rule in the selection of pumps for a water supply scheme with a lake as a source ? What are the appurtenances to be installed in the pipeline through the pump up to the overhead reservoir at the area being served ? **12**

(f) Describe with a sketch the storm water relief weir for a sewerage system. **12**

6. (a) For a station *L*, the recorded annual 24-hr maximum rainfall are given below. Compute the necessary data to estimate : (a) 24-hr maximum rainfall with a specified return period; and (b) probability of a rainfall of not less than a specified depth occurring in 24 hours at station *L*. Indicate the above features on a sketch (not necessarily plotted to exact data) prescribing the coordinate parameters.

1. Year	1960	61	62	63	64	65	66	67	68	69
2. Rainfall, cm	14.2	13.1	7.5	14.9	12.4	14.2	7.0	16.1	8.3	9.2

1. Year	70	71	72	73	74	75	76	77	78	79	80
2. Rainfall, cm	7.0	13.4	7.5	14.0	15.2	6.5	9.7	13.1	8.8	14.7	11.2

20

(b) Draw a schematic diagram (in plane view) of a barrage on an alluvial river, with provision for overflow and fish passage, for diversion of flow into a main canal, including for sediment extraction. On the diagram, label the several features and the schematic flow paths. **20**

(c) (i) Why are coagulants required in the sedimentation phase of water treatment ? What factors affect the dosage of coagulants ? **10**

(ii) A coagulation-cum-sedimentation tank is to be designed for the water works of a town having a population of 1.5 lakh. The average demand of water is 135 lpd/head and maximum demand is 1.5 times the average. The detention period is 6 hours. Flow rate is to be in the range near 1000 lph/m^2 of plan area. Design a system of rectangular sedimentation tanks. **10**

7. (a) Ordinates of a 4-hr unit hydrograph (u.h.g.) on a catchment are tabulated. Derive the ordinates of a 2-hr u.h.g. for the same catchment.

Time (hr)	0	4	8	12	16	20	24	28
Ordinate of 4-hr u.h.g. (m^3/s)	0	23	54	60	25	14	6	0

20

(b) (i) What are oxidation ponds ? What are their merits and demerits ? **10**

(ii) Design an oxidation pond for a colony of 2000 persons wherefrom the sewage flow is 150 lpd/head with a 5-day BOD of 300 ppm, providing a BOD loading of 200 kg/day/ha. 10

(c) (i) Find the requisite size of a combined circular sewer serving an area of 100 ha with a population of 60000 persons and supplied with water at 250 lpd/head. Take time of entry and time of flow of rain water to be 5 and 15 minutes, respectively. Runoff coefficient in rational formula is 0.45. Permissible velocity in the sewer is 3 m/sec. 10

(ii) What do you understand by "Limiting Velocity" in sewer design ? State the methods by which such a velocity is maintained. 10

8. (a) In a subsurface pipe drainage system, it is desired to keep the highest level of the water table at 1.5 m below the ground surface. The depth of impervious layer from land surface is 10.0 m and the depth of the drain below the land surface is 2.0 m. The mean annual rainfall in the area is 96 cm; and the coefficient of permeability is 6×10^{-6} m/s. Design the spacing of the drain pipes. 20

(b) (i) In single, as well as multiple, purpose water resources projects, how are benefits classified ? Give brief explanation for each; also indicate the distinction between "with/without" and "before/after" considerations. 10

(ii) What are the sources of radio-active wastes and the localities where they are incident generally ? What methods can be used for handling them to avert hazards to the public ? What are the chance factors in the failure of such preventive handling and disposal methods ? 10

(c) Describe the practices adopted in India for Industrial Zoning to control air pollution at the planning stage ? Within the industrial units individually, what are the methods to be enforced for control of industrial pollution ? 10