Indian Forest Service Examination-2012

D-GT-M-DFA

CIVIL ENGINEERING

Paper I

Time Allowed : Three Hours	*Maximum Marks : 200*

INSTRUCTIONS

Candidates should attempt Question Nos. 1 and 5 which are compulsory and any THREE of the remaining questions, selecting at least ONE question from each Section.

Assume suitable data, if considered necessary, and indicate the same clearly.

Standard notations are given in the questions and these notations have their usual meanings, unless otherwise indicated.

All questions have equal marks.

Marks allotted to each part/sub-part of a question are indicated against each.

Answers must be written in ENGLISH only.

Neat sketches may be drawn, wherever required.

Important Note : All parts/sub-parts of a question must be attempted contiguously. That is, candidates must finish attempting all the parts/sub-parts of each question they are answering in the answer-book before moving on to the next question.

Pages left blank must be clearly struck out. Answers that follow any pages left blank may not be given credit.

(Contd.)

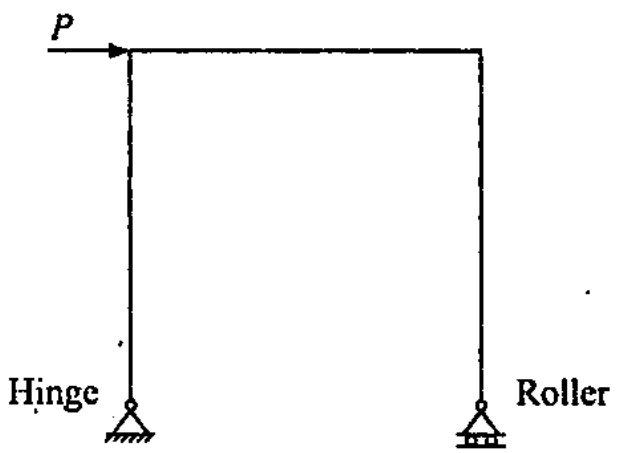
Section – A

1. (a) (i) Explain principle of superposition with an example. 4

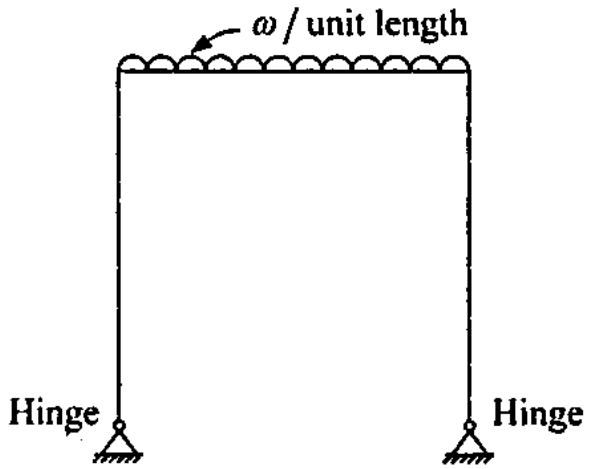
(ii) State the nature of failure of columns with the relevant equations related to stress. 4

(b) Draw qualitatively (without any calculation), the deflected shape and BM diagram for any two of the following structures : 8

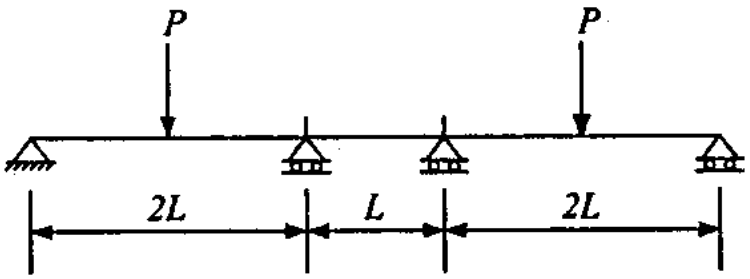
(i)



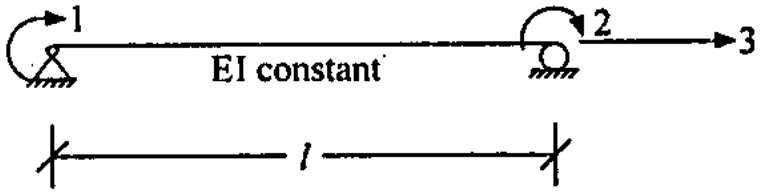
(ii)



(iii)



(c) Generate the stiffness matrix for the beam element shown in the following figure for the degrees of freedom 1, 2 and 3. 8



(d) A cohesionless soil has a permeability of 0·03 cm/sec at a void ratio of 0·32. Make the predictions for the permeability of this soil at a void ratio of 0·42 according to functions of void ratio that are proposed. 4+4

(e) (i) A pelton wheel develops power of 4470 kW under a head of 122 m at a speed of 200 r.p.m. Assume $Cv = \cdot 98$, $\phi = 0 \cdot 46$, efficiency = 88% and wheel diameter to jet diameter ratio of 9. Find the discharge required, diameter of wheel and diameter of jet and number of jets.

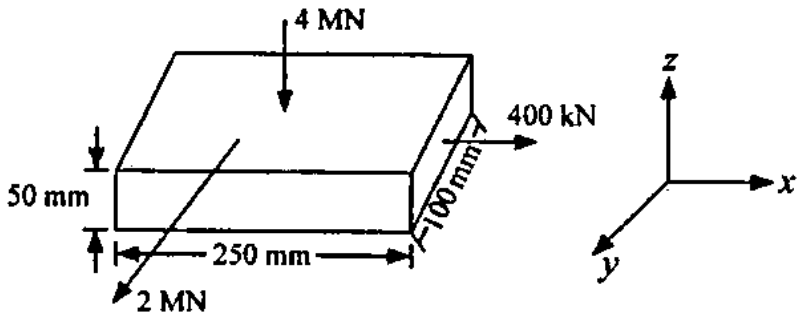
(ii) For a wide horizontal Rectangular channel, assuming Chezy's coefficient C to be constant in G.V.F.

Prove that

$$x = \frac{c^2}{g}\left[y - \frac{y^4}{4y_c^3}\right] + \text{constant}$$

where y is depth of flow
and y_c is the critical depth. 4+4

2. (a)



A metallic bar 250 mm × 100 mm × 50 mm is loaded as shown in the above figure. Work out the change in volume. What should be the change that should be made in the 4 MN load in order that there should be no change in the volume of the bar ? Assume $E = 2 \times 10^5$ N/mm^2 and Poisson's ratio = 0·25. 15

(b) A crane chain having an area of 7·25 cm^2 carries a load of 15 kN. As it is being lowered at a uniform rate of 50 m per minute, the chain gets jammed suddenly, at which time the length of chain unwound is 12 m. Estimate the stress induced in the chain due to the sudden stoppage. Neglect the weight of the chain. Assume $E = 2{\cdot}1 \times 10^5$ N/mm^2. 10

(c) Find the diameter of a solid cylindrical shaft subjected to 100 rpm and transmitting 350 kW power, wherein the shear stress not to exceed 90 N/mm^2.

What per cent saving in weight would be obtained if this shaft is replaced by a hollow one, whose internal diameter equals to 0·65 of the external diameter, the length, the material and maximum shear stress being the same. 15

3. (a) Design a reinforced concrete beam of rectangular section to carry a superimposed load of 32 kN/m over an effective span of 8 m. Overall depth of beam is restricted to 650 mm for architectural reasons. Width of the beam is 300 mm. Effective cover to reinforcement is 50 mm. M 20 concrete and Fe 415 steel are used. Use limit state method.

Modification factor (K_t) for different percentage of tension steel (p_t)

p_t	0·6	0·7	0·8	0·9	1·0	1·1	1·2	1·3	1·4	1·5	1·6
K_t	1·16	1·11	1·07	1·03	1	0·98	0·95	0·94	0·92	0·90	0·89

Modification factor K_c for different percentage of compression steel (p_c)

p_c	0·15	0·2	0·3	0·4	0·5	0·6	0·7	0·8	0·9	1·0
K_c	1·05	1·06	1·09	1·12	1·14	1·17	1·19	1·21	1·23	1·27

Design shear strength τ_c for concrete of M 20 grade.

% of steel	0·9	1·0	1·1	1·2	1·3	1·4	1·5	1·6
τ_c N/sq.mm	0·6	0·62	0·64	0·66	0·68	0·7	0·72	0·73

20

(b) A r.c. retaining wall is required to retain earth for a height of 4 m above ground level. Top surface of the earth retained is horizontal. Density of earth is 18 kN/cu.m and the angle of repose of the soil is 30°. Safe bearing capacity of soil is 200 kN/sq.m and coefficient of friction between concrete and earth = 0·6. Select suitable dimensions for the components of the retaining wall and check the stability of the wall. Design the vertical stem only using M 20 concrete and Fe 415 steel. Provide a sketch indicating the reinforcements in the stem. 20

4. (a) A 8·0 m high retaining wall supports a soft saturated clay as backfill. The shear strength parameters obtained in undrained conditions were C_u = 19·5 kN/m^2 and $\phi_v = 0$. If unit weight of soil is 18 kN/m^3. Find

(i) The maximum depth of tensile crack 5

(ii) The active force before the tensile crack occurs 5

(iii) The active force after the occurrence of tensile crack 5

(b) Design a square pile group to carry a load of 400 kN in a clay strata with unconfined compressive strength of 60 kN/m^2. The piles are 30 cm in diameter and 6·0 m long. Adhesion factor may be taken as ·58. 15

(c) A 11·5 m high embankment is inclined on sides at angle 30° to the horizontal. If the shear strength parameters of the soil are C = 20 kN/m^2 and $\phi = 20°$, determine the factor of safety available against slope failure. The unit weight of soil is 20 kN/m^3. The value of Sn from Taylor Chart for $\phi = 20$ and $\beta = 30$ is 0·025. 10

Section – B

5. (a) A pretensioned beam 240 mm wide and 300 mm deep is prestressed by 12 No. H.T. wires each of 7 mm diameter initially stressed to 1200 N/mm^2 with their centroid located

100 mm from the soffit. Estimate the final percentage of loss of stress due to elastic shortening, creep of concrete, shrinkage of concrete and relaxation of H.T. steel on the basis of following data :

E_s = 210 kN/mm^2,

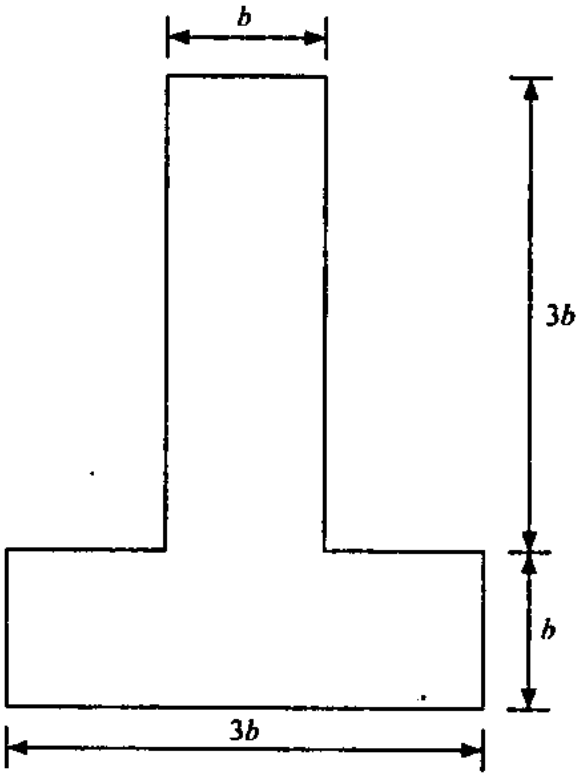
E_c = 35 kN/mm^2,

Creep coefficient = 1·6,

Residual shrinkage strain = 3×10^{-4} and

Relaxation of steel stress = 90 N/mm^2. 8

(b)



Calculate the shape factor and the fully plastic moment M_p of the section shown in the above figure. Assume yield stress = σ_y in both tension and compression. 8

(c) Explain soundness of cement and describe the procedure to determine the soundness of cement. 8

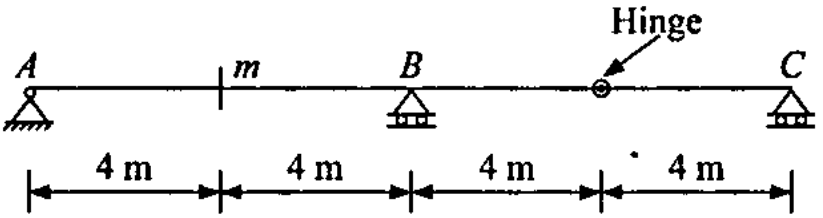
(d) Establish the relationship for shear strength in case of Vane shear test.

$$T_f = \frac{2T}{\pi d^3(h + d/3)}$$

where h is height of vane
d is the diameter of vane
T is torque
T_f is shear strength of soil 8

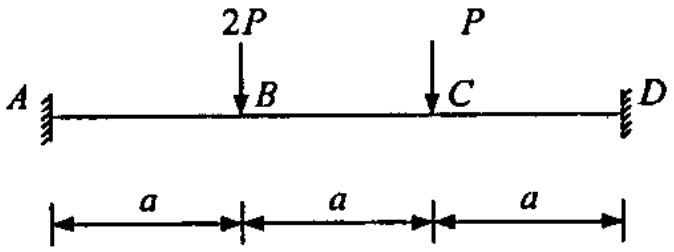
(e) Give at least two important uses and limitations of flow nets. Name four approximate methods of Drawing flow nets. 8

6. (a)



Draw influence line diagrams for the vertical reaction at support B and BM and SF at section m of the beam shown in the above figure using Müller-Breslau principle or otherwise. Plot the values of the ordinates at few sections along the beam. Calculate the maximum values of the above functions when 2 wheel loads of 5 kN each placed 1 m apart cross the beam. 15

(b)



Calculate the collapse load for the beam shown in the above figure by both mechanism method and statical method.

Assume the beam to be of constant section, the fully plastic moment being M_p. 25

7. (a) A rectangular channel 3 m wide and 1·8 metre deep discharging 18 m^3/sec, suddenly has its discharge reduced to 12 m^3/sec at the down stream end.

Compute the speed and height of the surge moving D/s. 10

(b) Give at least ten practical applications of hydraulic jump. 10

(c) A four stage reciprocating pump has cylinders of 400 mm diameter and stroke of 600 mm each. The pump has to deliver 0·5 m^3/sec of water at an elevation of 300 m above the sump level. The friction loss in delivery and suction pipes are 25 and 5 metres. Take velocity of water in delivery pipe as 2 m/sec, efficiency = 0·8 and slip is 2%. Compute the speed and power required to drive the pump. 10

(d) Show that for a hydraulic jump in a horizontal frictionless rectangular channel

$$\frac{Fr_2^2}{Fr_1^2} = \frac{8}{\left[-1+\sqrt{1+8\,Fr_1^2}\right]^3}$$ 10

8. (a) A normally consolidated clay stratum with liquid limit of 42% and 6·4 m thickness is located at a depth of 9·5 m below the present existing ground surface. The clay has natural moisture content of 35% and has a specific gravity of 2·68. The subsoil consists of very fine sand between the ground surface and clay. The water table is located at 3·5 m below the ground surface.

Unit weight of sand above the water table is 18 kN/m^3. Average submerged unit weight of sand is 11 kN/m^3. A new building is to be constructed at the ground level and it exerts an effective increased overburden pressure on clay by 40 kN/m^2.

Estimate the settlement of building. 10

(b) (i) Crude oil is to be pumped at a rate of 18 m^3/hr, through a 100 metre long pipe of diameter 0·3 m. The delivery point of the pipeline is 5 metre vertically above the entry point. The specific gravity of the crude oil is equal to 0·86 and kinematic viscosity is $0{\cdot}135 \times 10^{-4}$ m^2/sec. Calculate

(I) Maximum velocity of the oil in the pipe

(II) The frictional head loss

(III) The power required to pump the oil

(ii) Explain the significance of "Knudsen" number.

(iii) Distinguish between pre-tensioned and post-tensioned pre-stressed concrete clearly describing the step by step procedures involved. 10

(c) (i) Explain laterally unsupported beams. 5

(ii) Two channels of ISMC 400 at 49·4 kg/m placed back to back are used as a laterally supported beam over a span of 6·0 m (simply supported). It is subjected to a $\mu. d. l.$ of 1 t/m and two concentrated loads of F each at 1/3 points. If $P_s = 1600$ kg/cm^2 find F and also the maximum deflection in the beam.

Find an equivalent I-Beam to support the same load over the same span. Comment on the efficiency of the sections in resisting the loads.

Properties of the channel section ISMC 400 :

$Z_{xx} = 754{\cdot}1$ cm^3. $I_{xx} = 15082{\cdot}8$ cm^4.

Properties of I-Beam–ISLB 500 at 75 kg/m.

$I_{xx} = 38579$ cm^4

$Z_{xx} = 1543{\cdot}2$ cm^4. 15
