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भारतीय वन सेवा परीक्षा... 2011...
Indian Forest Services Examination

D-VSF-L-PRA

CIVIL ENGINEERING

Paper I

Time Allowed : Three Hours

Maximum Marks : 200

INSTRUCTIONS

Candidates should attempt Questions No. 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/subpart of a question are indicated against each.

Answers must be written in ENGLISH only.

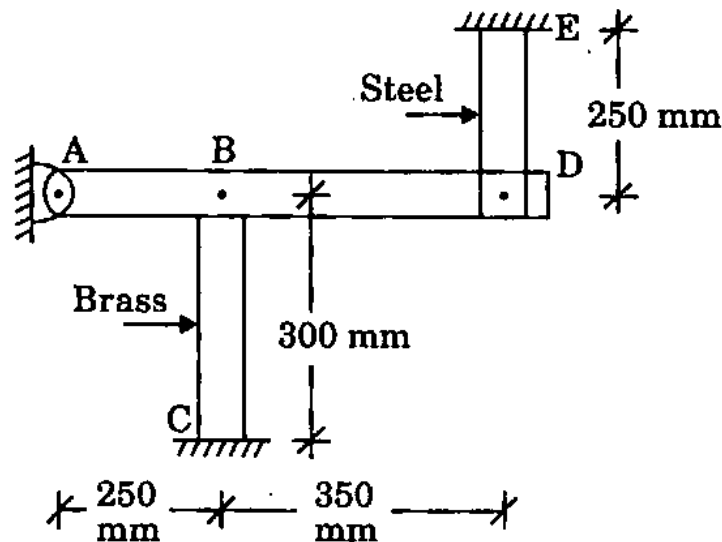
SECTION A

1. Attempt any *four* of the following :

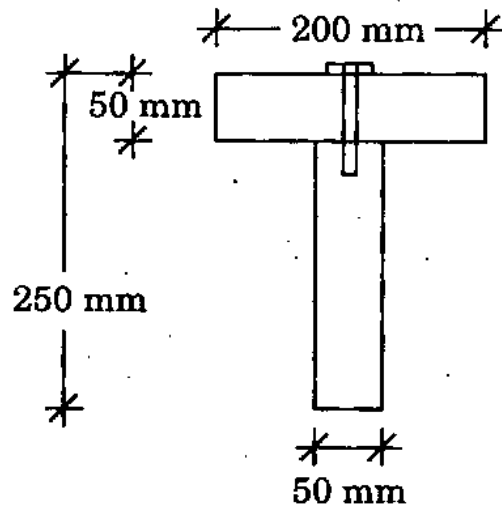
10×4=40

- (a) A rigid bar AD is pinned at A and attached to the bars BC and ED as shown in the figure. The entire system is initially stress free and the weights of all bars are negligible. The temperature of the bar BC is lowered 25°C and that of bar ED is raised 25°C. Neglecting any possibility of lateral buckling, find the normal stress in bars BC and ED. For BC, which is brass, assume $E = 90 \text{ GPa}$, $\alpha = 20 \times 10^{-6}/^\circ\text{C}$ and for ED, which is steel, take $E = 200 \text{ GPa}$ and $\alpha = 12 \times 10^{-6}/^\circ\text{C}$. The cross-sectional area of BC is 500 mm^2 and of ED is 250 mm^2 .

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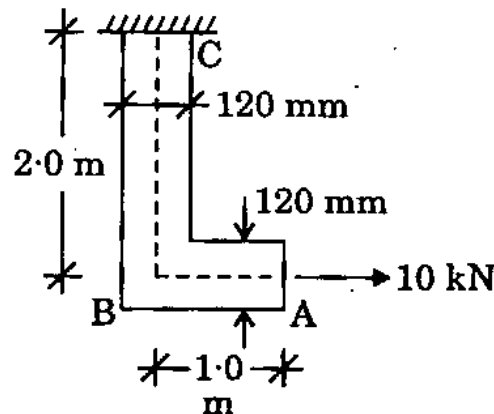


- (b) Two long wooden planks form a T-section of a beam, as shown in figure. If this beam transmits a constant vertical shear of 3000 N, find the necessary spacing of the nails between the two planks to make the beam act as a unit. Assume that the allowable shear force per nail is 700 N. 10



- (c) The L-shaped bar shown in figure is of uniform cross-section 60 mm \times 120 mm. Calculate the total strain energy. 10.

Take $E = 2 \times 10^5$ MPa and $G = 0.8 \times 10^5$ MPa.



- (d) Two pipes A and B are connected in parallel between two reservoirs M and N. The details of the two pipes are as follows :

Pipe	Length (m)	Diameter (mm)	Darcy - Weisbach friction factor (f)
A	500	300	0.025
B	800	250	0.020

What difference in the water surface elevations of the reservoirs M and N would produce a flow of $0.30 \text{ m}^3/\text{s}$ of water from the higher reservoir to the lower one ? Neglect minor losses. 10

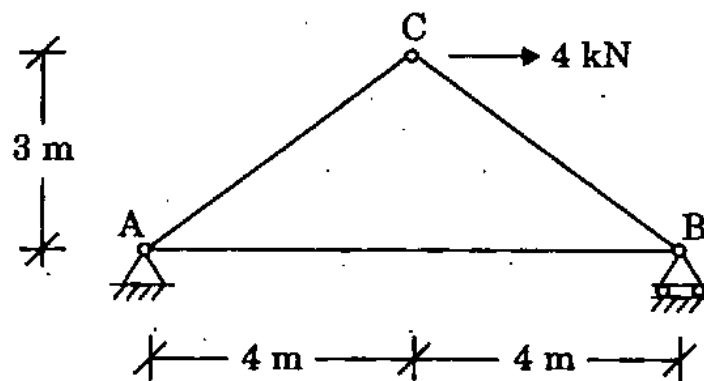
- (e) The time period T of water surface wave is known to depend on the wavelength λ , depth of flow D , density of the fluid ρ , acceleration due to gravity g and the surface tension σ . Using Buckingham's π -theorem, obtain the dimensionless form of functional relationship. 10

2. (a) The cross-sectional area of each member of the truss shown below is $A = 400 \text{ mm}^2$, and $E = 200 \text{ GPa}$.

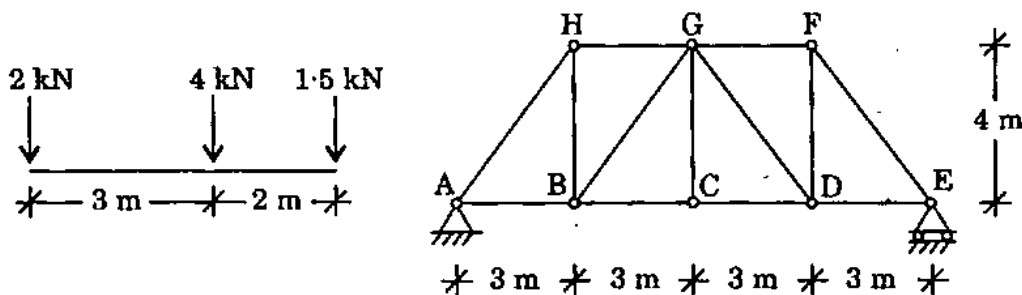
(i) Determine the vertical displacement of joint C if a 4 kN force is applied to the truss at C.

(ii) If no loads act on the truss, what would be the vertical displacement of joint C if member AB were 5 mm too short? Use unit load method.

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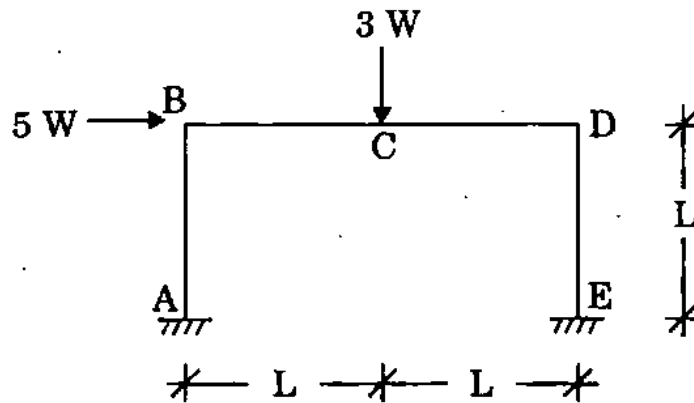
- (b) Draw the influence line diagram for the truss shown below for member BG. Determine the maximum compressive force developed in member BG of the truss due to wheel loads crossing the truss. Assume the loads are applied directly to the truss and move from left to right. Support A is hinge and Support E is roller. 15



- (c) At a certain point in a piece of elastic material there are normal stresses of 30 MPa, tension and 20 MPa, compression on two planes at right angles to one another, together with shearing stresses of 15 MPa on the same planes. If the loading on the material is increased so that the stresses reach values of K times those given, find the maximum values of K if the maximum direct stress in the material is not to exceed 80 MPa, and the maximum shear is not to exceed 50 MPa. 10

3. (a) Find the collapse load for the given frame. Use kinematic method.

12

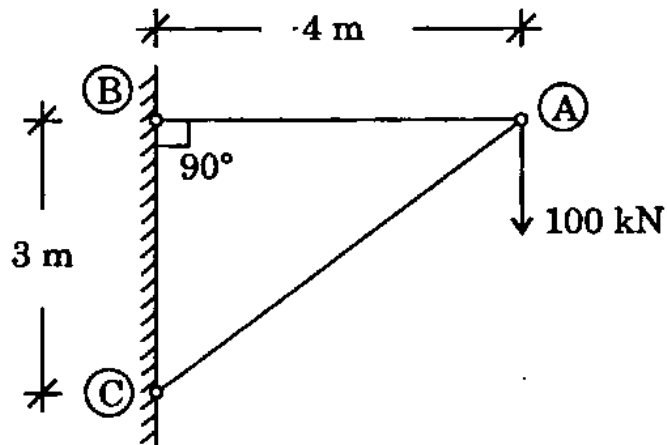


Column section = $2 M_P$

Beam section = M_P

- (b) The truss shown below carries a vertical load of 100 kN at A. Determine the displacement of joint A. Also, calculate the member forces in members AB and AC. Use stiffness method only.

8



$$A_{AB} = 10,000 \text{ mm}^2$$

$$A_{AC} = 20,000 \text{ mm}^2$$

$$E = 200 \text{ kN/mm}^2$$

- (c) A pipeline carrying water has a 60° reducing bend in a horizontal plane. The cross-sectional areas at inlet and outlet of the bend are 1.0 m^2 and 0.5 m^2 respectively. The pressures at inlet and outlet of the bend are 40 kN/m^2 and 30 kN/m^2 respectively. The discharge in the pipe is measured as $10 \text{ m}^3/\text{s}$. Calculate the magnitude and direction of the force required to hold the bend in position. Take the density of water as 1000 kg/m^3 . 10
- (d) Water flows at a steady and uniform depth of 2.5 m in an open channel of rectangular cross-section having base width equal to 4 m and laid at a slope 1 in 1000. It is desired to obtain critical flow in the channel by providing a hump in the bed. Calculate the minimum height of the hump. Also sketch the flow profile and label salient features. Consider the value of Manning's coefficient $n = 0.02$ for the channel surface. 10
4. (a) A highly viscous oil is to be transported through a pipe in laminar mode. The discharge is 30 litres/s and the energy gradient is limited to 0.02 . Estimate the smallest diameter of the pipe for this purpose. If this diameter is used, what would be (i) the Reynolds number and (ii) power required per kilometer of the pipeline? Take density and dynamic viscosity of oil as 960 kg/m^3 and 0.98 kg/m.s respectively. 10

(b) A rectangular lined canal ($n = 0.016$) of 4.0 m width has a bottom slope of 0.0009. It carries a discharge of $15 \text{ m}^3/\text{s}$ and the normal depth is known to be 2.0 m. The flow is non-uniform in a certain reach. If the depth of flow at section A in this reach is 2.6 m,

(i) Calculate the depth of flow at a section B which is 500 m downstream of section A. Use direct step method by taking two steps; one step to depth 2.8 m and another to depth 2.88 m.

(ii) Classify the gradually varied flow profile between A and B.

20

(c) A Kaplan turbine has the following features :

Outer diameter of the runner = 4.5 m

Hub diameter = 2.0 m

Guide vane angle at outer edge of blades = 59°

Inlet blade angle at the blade tip = 19°

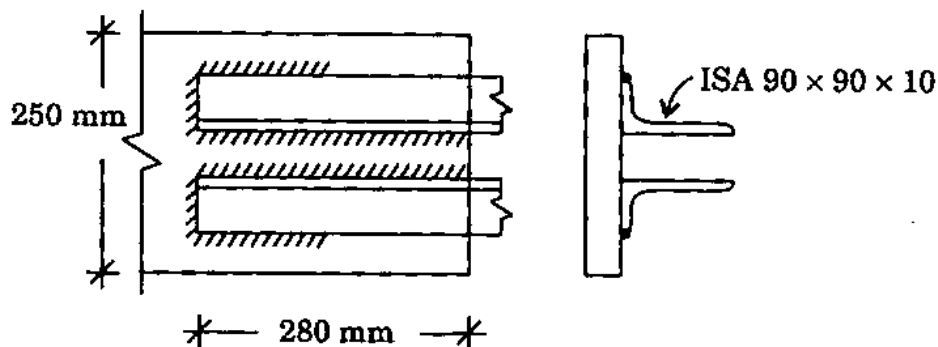
The hydraulic and overall efficiencies are 0.92 and 0.90 respectively. If the discharge through the turbine is $120 \text{ m}^3/\text{s}$, determine the (i) speed and (ii) power developed by the turbine. The discharge at the outlet of the runner can be taken as axial. Take unit weight of water as $\gamma = 9.79 \text{ kN/m}^3$.

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SECTION B

5. Attempt any *four* of the following : 10×4=40

- (a) A member consisting of two ISA 90 × 90 × 10 mm back-to-back welded on one face of a gusset plate are tack welded at 1000 mm spacing. The assembly is subjected to tension. Determine the tension capacity of the member and weld requirement. Area of cross-section of one ISA 90 × 90 × 10 is 1703 mm². Use 8 mm thick weld in calculations. 10



- (b) Design the shear reinforcement for a factored shear force of 100 kN. The cross-section is 250 mm × 400 mm. Assume M 20 grade concrete and Fe 415 reinforcement. Effective cover is 35 mm. The shear strength of concrete (τ_c) is 0.73 MPa corresponding to the longitudinal steel. Adopt 8 mm diameter as web reinforcement. 10

(c) The mass specific gravity of a saturated specimen of clay is 1.84 when the water content is 38%. On oven drying, the mass specific gravity falls to 1.70. Determine the specific gravity of solids and shrinkage limit of the clay. 10

(d) A footing 3 m × 2 m in size, transmits a pressure of 140 kN/m² on a soil having $E = 5 \times 10^4$ kN/m² and $\mu = 0.50$. Find the immediate settlement for the footing at the centre, assuming it to be (i) flexible footing, (ii) rigid footing.

For $\frac{L}{B} = 1.5$, Influence factor = 1.36 for flexible and 1.06 for rigid footing. 10

(e) Undisturbed soil sample of 2 m thick stratum, was tested in the laboratory and the average value of co-efficient of consolidation was found to be 2×10^{-4} cm²/sec. If a building is constructed on this stratum, how long will it take to attain half the ultimate settlement. Soil stratum is having double drainage. 10

6. (a) An RC beam 300 mm wide and 500 mm deep overall is reinforced with 4 nos. of 16 mm diameter on tension face. The effective cover to centre of reinforcement is 50 mm. Find the moment of resistance and the safely distributed load the beam can carry. The span is 5 m. 15

Take

$$f_{ck} = 20 \text{ MPa (Grade of concrete),}$$

$$f_y = 415 \text{ MPa (Grade of steel) and}$$

$$\text{unit weight of concrete} = 25 \text{ kN/m}^3.$$

- (b) Analyze the beam described below using load balancing concept. 10

Span of the beam = 10.0 m

Cross-section = 400 × 600 mm (rectangular)

External load = 30 kN/m (udl)

Unit weight of concrete = 24 kN/m³

Prestressing force (P) = 1800 kN

Cable profile = parabolic

Eccentricity at mid cross-section = 155 mm

Eccentricity at support section = 0 mm

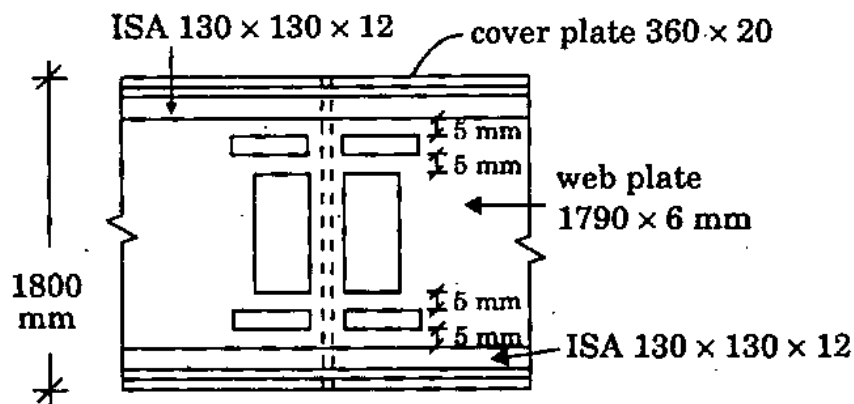
- (c) Determine the dimensions of an isolated footing subject to a factored axial load $P_u = 1000$ kN and a factored uniaxial moment $M_u = 120$ kNm (with respect to the major axis) at the column base. Assume that moment is reversible. The safe bearing capacity of the soil may be taken as 200 kN/m^2 at a depth of 1.5 m. One side of footing width is restricted to 2.0 m. Assume M 20 concrete and Fe 415 steel.

Calculate the footing depth from one way shear and two way shear considerations. Shear stress of concrete is limited to 1.12 MPa.

(Design of reinforcement not necessary).

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7. (a) The following figure shows a section of a girder where the bending moment is 2500 kNm and shear is 600 kN. Design a triple plate shear splice using 22 mm diameter power driven shop rivets. Adopt allowable tensile stress of 142 MPa. 20



Area of cross-section of ISA 130 × 130 × 12 =
29.82 cm².

Double shear strength of rivet = 100 MPa.

Bearing strength = 236 MPa.

Limit allowable flexural compressive / tensile stress to 94.5 MPa.

- (b) (i) What is Quick Sand Phenomenon ? Calculate critical hydraulic gradient for a coarse grained soil having voids ratio 0.7 and specific gravity 2.70. Discuss the result. 10
- (ii) A concentrated load of 2000 kg acts on the surface of homogeneous soil of large extent. Find the stress intensity at a depth of 15 m (i) directly under load, (ii) at a distance of 7.5 m (horizontal). Use Boussinesq equation. 10
8. (a) An unconfined compression test was conducted on an undisturbed sample of clay. The sample had a diameter of 37.5 mm and was 80 mm long. The load at failure measured by the proving ring was 28 N and the axial deformation of the sample at failure was 13 mm. Determine UCS and C_u of the clay. 10
- (b) A saturated soil has a compression index of 0.25. Its void ratio at a stress of 10 kN/m^2 is 2.02 and its permeability is $3.4 \times 10^{-7} \text{ mm/s}$.
Compute
- (i) Change in void ratio if the stress is increased to 19 kN/m^2 .
- (ii) Settlement if stratum is 5 m thick.
- (iii) Time required for 40% consolidation if drainage is two way. 20

- (c) Design a square pile group to carry 400 kN in clay with an unconfined compression strength of 60 kN/m^2 . The piles are 30 cm diameter and 6 m long. Adhesion factor may be taken as 0.6. 10

