

2009

CIVIL ENGINEERING (Paper I)

106277

Time allowed : 3 Hours }

{ Maximum Marks : 200

Note :

- (i) Solve one question from each section.
- (ii) If more than one question are attempted in a section, the excess will be ignored.
- (iii) Figures to the right indicate the number of marks for the question / sub-question.
- (iv) Make suitable assumptions, if necessary and state the same.
- (v) Use of log-tables, non-programmable calculators is permitted.
- (vi) Use of any kind of I.S. Codes and Steel Table Codes is NOT permitted.
- (vii) Candidate should not write roll number, any name (including their own), signature, address or any indication of their identity anywhere inside the answer book otherwise he/she will be penalised.

SECTION - A

1. (A) What should be the value of ' θ ' of the inclined plane shown in Figure 1, which will make the motion of 900 N block down the plane to impend? The coefficient of friction for all contact surfaces is $\frac{1}{3}$. 12

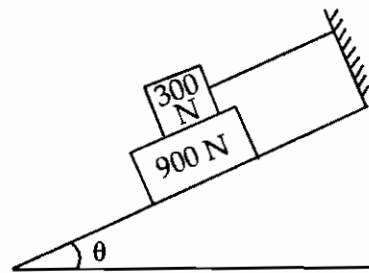


Figure 1 [Q. No. 1 (A)]

- (B) A man wishes to move a wooden box of 1 m cube to a distance of 5 m with the least amount of work. If the block weighs 1 kN and the coefficient of friction is 0.3, determine whether he should tip the box or slide it. 11

P.T.O.

- (C) A cord ACB, 5 m long is attached at points A and B to two vertical walls 3 m apart as shown in Figure 2. A pulley C of negligible weight and size carries a suspended load of 200 N and is free to roll without friction along the cord. Determine the position of the load as defined by its horizontal distance from one of the walls so that the system is in equilibrium. For this position determine tension in the cord. 11

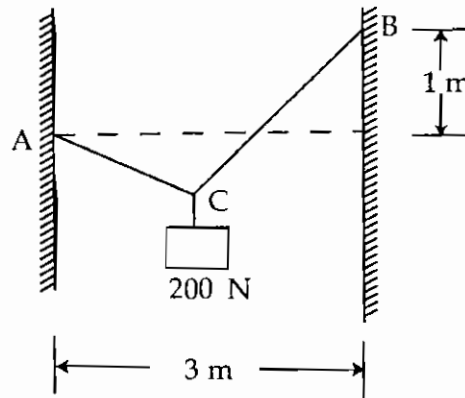
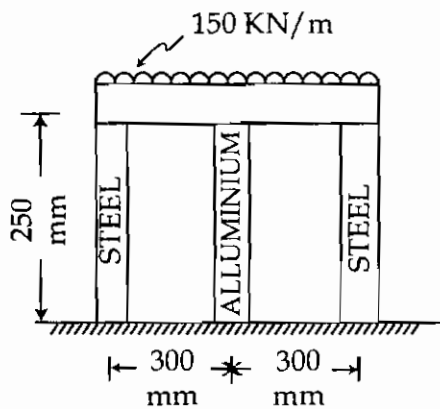


Figure 2 [Q. No. 1 (C)]

2. (A) A rigid bar is fixed to the top of three posts made of steel and aluminium as shown in Figure 3. The length of all the posts is 250 mm when no load is applied and the temperature is 20 °C. Determine the reaction offered by each of the posts if the horizontal bar is subjected to a uniformly distributed load of 150 kN/m and the temperature is raised to 80 °C. The coefficients of thermal expansion of the materials are $\alpha_{\text{steel}} = 12 \times 10^{-6}/^{\circ}\text{C}$ and $\alpha_{\text{aluminium}} = 23 \times 10^{-6}/^{\circ}\text{C}$. 12



Diameter of steel bars = 40 mm

Diameter of aluminium bar = 60mm

Figure 3 [Q. No. 2 (A)]

- (B) Draw the BMD and SFD for the compound beam shown in Figure 4. Showing salient values. 10

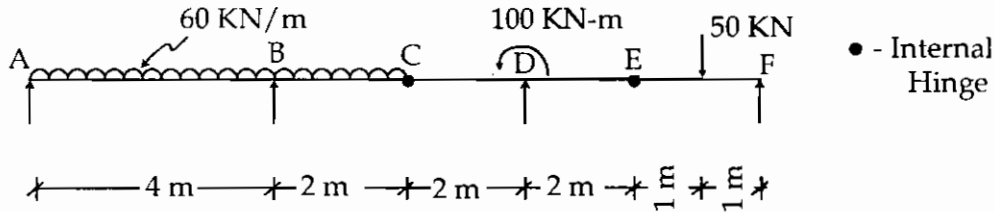


Figure 4 [Q. No. 2 (B)]

- (C) Determine the equation of the elastic curve for the cantilever beam shown in Figure 5. Also find the deflection at B and C. Assume EI constant. 12

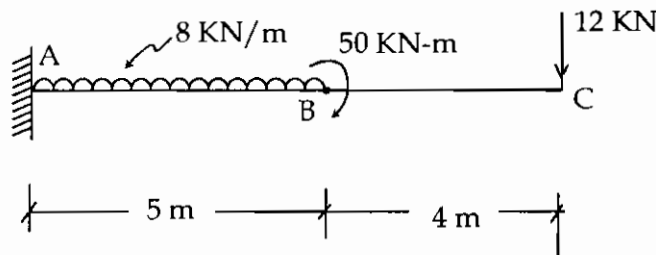


Figure 5 [Q. No. 2 (C)]

SECTION - B

3. (A) A fixed beam ACB of length $2L$ is fixed at A and B, $AC = CB = L$. While portion AC has a moment of inertia of $2I$, portion CB has a moment of inertia of I . If the beam is subjected to a uniformly distributed load of ' ω ' per unit length over the entire span, determine the fixed-end moments at A and B using slope-deflection method. 12
- (B) A rigid portal frame ABCD has two unequal vertical legs, $AB = 4\text{m}$ and $CD = 6\text{m}$ with member BC horizontal and 8m long. The supports A and D are fixed and all the members have same moment of inertia I . The member BC carried a uniformly distributed load of 40 kN/m and a horizontal force ' H ' acts at joint C. Find the magnitude and sense of the force ' H ' such that the frame does not sway under the given loading. Use moment - distribution method. 13
- (C) A two-span continuous beam ABC has simple supports at A and C and $AB = BC = L$. Span AB carries a central concentrated load of ' P '. Compute the redundant reaction at the central continuous support B if it settles by ' Δ '. Use consistency of deformation method. 9

4. (A) A cable is suspended between two points A and B located 50m apart horizontally. B is higher than A by 12.5 m. At the midpoint of the span AB, the cable is 9.375 m below the point A. The cable carries a uniformly distributed load over the span. Determine the position and sag of the lowest point and curved length of the cable. **11**

(B) Using the Muller-Breslau principle draw the influence line diagrams for the following actions for the compound beam shown in Figure. 6 and show the salient values. **10**

- (i) Moment at A (ii) Reaction at C (iii) Shear force at D
- (iv) Moment at E (v) Vertical reaction at H

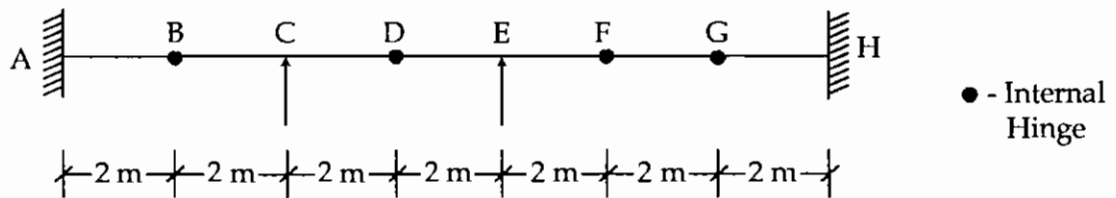


Figure 6 [Q. No. 4 (B)]

(C) Using the stiffness approach of analysis, analyse the pin-jointed truss shown in Figure 7. Axial rigidity of all the members is same. **13**

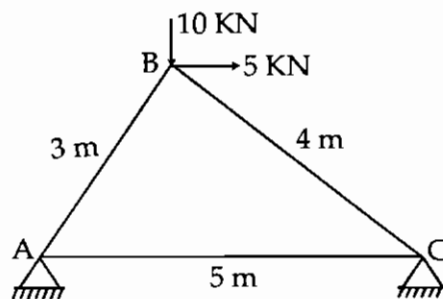


Figure 7 [Q. No. 4 (C)]

SECTION - C

5. (A) Calculate the shearing stress in the rivets B and C for the connection shown in Figure 8. Rivets A and B are 14 mm in diameter, while rivet C has a diameter of 22 mm. 10

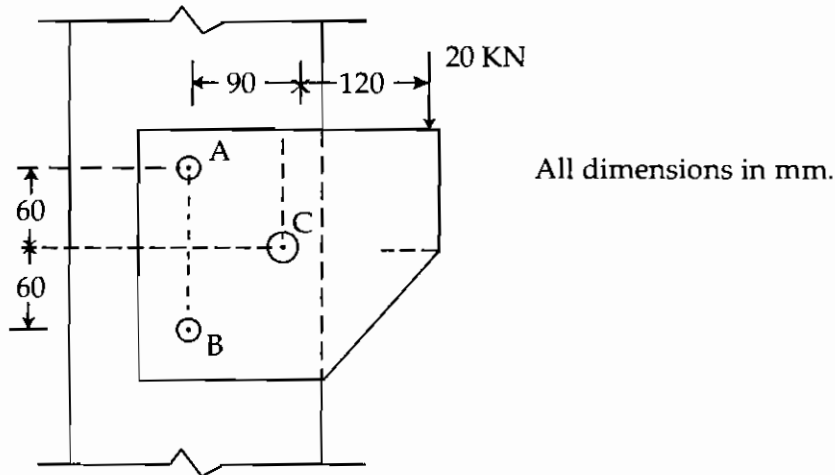


Figure 8 [Q. No. 5 (A)]

- (B) A built-up column consists of ISHB 400 @ 77.4 kg/m with one 300 mm x 12mm flange plate on each side. The column carries an axial load of 2400 kN. Design a gusseted base for the column, if it is supported on a concrete pedestal with a bearing capacity of 4 N/mm². Relevant properties of the sections are as given below : 13

ISHB 400 @ 77.4 kg/m : $h = 400$ mm, $b = 250$ mm

ISA 150 x 115 x 15 mm : Root radius = 11 mm

ISA 150 x 115 x 10 mm : Root radius = 11 mm

- (C) A laterally supported beam having an effective span of 8 m consists of ISMB 550 @ 103.7 kg/m and cover plate of 250 mm x 16 mm connected to each flange by 20 mm diameter rivets. Determine the safe uniformly distributed load which the beam can carry in addition to its own weight. Properties of ISMB 550 @ 103.7 kg/m are as given below : 10

$$I_{xx} = 64893.6 \times 10^4 \text{ mm}^4, \quad I_{yy} = 1833.8 \times 10^4 \text{ mm}^4,$$

$$Z_{xx} = 2359.8 \times 10^3 \text{ mm}^3, \quad Z_{yy} = 193 \times 10^3 \text{ mm}^3,$$

$$h = 550 \text{ mm}, \quad b = 190 \text{ mm}, \quad t_f = 19.3 \text{ mm}, \quad t_w = 11.2 \text{ mm},$$

$$a = 13211 \text{ mm}^2$$

6. (A) A RC beam of span 3 m carries a uniformly distributed featured load of 120 KN/m over the span. The beam has a uniform width of 300 mm with overall depth varying from 650 mm at support to 400 mm at the free end. The beam is reinforced with 2 – 20 mm diameter bars on compression side and 5 – 28 mm diameter bars on tension side at an effective cover of 50 mm. Two of the tensile bars are curtailed at a distance of 1 m from the support. Design the shear reinforcement assuming M20 concrete and Fe 415 steel. Design shear strength of M20 concrete for different tensile steel are as given below. 13
- | | | | | |
|-------------------------------|------|------|------|------|
| 100 As/bd | 1.00 | 1.25 | 1.50 | 1.75 |
| τ_c (N/mm ²) | 0.62 | 0.67 | 0.72 | 0.75 |
- (B) Design a circular RC column 390 mm in diameter having spiral reinforcement subjected to a factored axial load of 1750 KN. The column is braced against sidesway and has an unsupported length of 3.3 m. Use M 25 concrete and Fe 415 steel. 10
- (C) Design an isolated footing for a RC column of size 300 mm × 350 mm carrying an axial load of 750 KN. The safe bearing capacity of soil is 175 KN/m². The unit weight of soil is 19.5 KN/m³. Use M20 concrete and Fe 415 steel. 10

SECTION - D

7. (A) A retaining wall is to be designed to retain soil upto a height of 5.0 m above ground level. Using limit state approach, design the stem assuming 20
- (i) a cantilever type retaining wall and
- (ii) counterfort type retaining wall. Comment on the suitability of each one of them based on your design. Assume the following data.
- | | |
|--------------------------------------|----------------------|
| Unit weight of horizontal backfill - | 18 KN/m ³ |
| Angle of internal friction | - 30° |
| Depth of foundation | - 1.5 m below GL. |
| Grade of concrete | - M 20 |
| Grade of steel | - Fe 415 |
- C/C distance of counterforts when provided - 3 m.
- (B) Design a 3 - span continuous beam of a typical interior idealised plane frame of a building. The frames are spaced 5.5 m apart and in a typical floor 140 mm continuous slab is cast monolithically with the beams. The thickness of floor finish is 40 mm. The beam has three equal spans of 6.1 m each. The floor is to support an imposed load of 5 KN/m². at the service state. The unit weight of finishing material is 20 KN/m³. Materials to be used are M 20 grade concrete and Fe 415 steel. Restrict the design to flexural design only. 13

8. (A) An open rectangular tank of size 3 m × 5 m in plan and 3.5 m high, resting on firm ground is to be used for storing water. Design the side walls of the tank using M 20 concrete and Fe 415 steel. 13
- (B) What do you understand by workability of concrete ? Discuss any three methods of determining workability of concrete and state the conditions under which each of the methods are suitable. 10
- (C) Write notes on 10
- (i) creep and shrinkage of concrete
- (ii) Alkali-aggregate reaction.

SECTION - E

9. (A) A simply supported pre-stressed concrete beam 400 mm wide and 600 mm deep is loaded with a uniformly distributed load of 60 kN/m over a span of 6 m. The beam is pre-stressed with a parabolic tendon with an eccentricity of 100 mm at the ends and 200 mm at midspan. The tendon is pre-stressed with a force of 1920 kN. Using the load balancing concept determine the extreme fibre stresses. 11
- (B) A post tensioned PSC beam of 30 m span is subjected to a pre-stressing force of 2500 kN. The cable profile is parabolic with a maximum eccentricity of 200 mm at midspan and zero eccentricity at the ends. The beam has a cross - section of 500 mm × 800 mm and is pre-stressed with 9 cables, one at a time, each cable consisting of 12 wires of 5 mm diameter. Taking $E_s = 2.1 \times 10^5 \text{ N/mm}^2$, $E_c = 3.5 \times 10^4 \text{ N/mm}^2$, $\mu = 0.3$, coefficient of wave effect $K = 15 \times 10^{-4}$ per metre determine the prestress loss due to 14
- (i) Elastic shortening
- (ii) Friction.
- (C) Write notes on : 8
- (i) Anchorage stresses
- (ii) Concepts of pre-stressing
10. (A) Explain with neat sketches different types of pre-cast slab panels which are used in pre-cast construction. 12
- (B) Write notes on : 12
- (i) Modern erection techniques of pre-cast member.
- (ii) Design criteria for pre-cast slab panels.
- (iii) Quality control in pre-cast construction.
- (C) Discuss the design procedure of a rectangular pre-stressed concrete beam. 9

SECTION - F

11. (A) Explain the Newton Raphson Method for solution of non-linear algebraic equations. Solve the following equation using this method. **12**
 $x^3 - 2x^2 - 5x + 6 = 0$
- (B) Write an algorithm and flow-chart for solving a set of three simultaneous equations using Guass-elimination method. **14**
- (C) What do you understand by "Banded Matrix" ? Give examples from structural analysis where you come across with such matrices. **7**
12. (A) Explain Gauss-seidel iterative method. Solve the following set of equations using Gauss-seidel method. **12**
$$3x_1 + 4x_2 - 6x_3 = 10$$
$$6x_1 - 3x_2 + 4x_3 = 15$$
$$8x_1 + 6x_2 - 7x_3 = 25$$
- (B) An overhanging beam ABC has supports at A and B and portion BC is overhanging. AB=5 m and BC=2 m. Portion AB is subjected to a uniformly distributed load of 20 KN/m and portion BC is subjected to uniformly distributed load of 25 KN/m. Find the bending moment values at an equal intervals of 1 m and determine the area under the BMD using Simpson's rule. **12**
- (C) Draw flow chart and write a computer programme for designing a simply supported reinforced concrete beam. Use Fortran or C language. **9**