Maharashtra Engineering (Civil) services Main Examination - 2011

GRM

101200

2011

CIVIL ENGINEERING (Paper - I)

Time allowed : 3 Hours] **[Maximum Marks : 200**

Note :

(i) *Solve any one question from each section.*

(ii) *Do not reproduce any question. Write only question number against the answer.*

(iii) *Number of optional questions up to the prescribed number in the order in which questions have been solved, will only be assessed and excess answers of the question/s will not be assessed.*

(iv) *Figures to the right indicate the number of marks for the questions.*

(v) *Assume suitable data if necessary and state-it clearly.*

(vi) *Use of Non-programmable calculators is permitted.*

(vii) *Use of I.S. Codes and Steel Table, is* ***not*** *permitted.*

(viii) *Candidate should not write roll number, any name (including his/her own), signature, address or any indication of his/her identity any where inside the answer book otherwise the candidate will be penalised.*

SECTION - A

1. (a) A beam ABCD supported at B and C has over hangs AB and CD. The shear force diagram for the beam is shown in Figure 1. Determine the loading diagram with couple at pt. F and the bending moment diagram. **10**

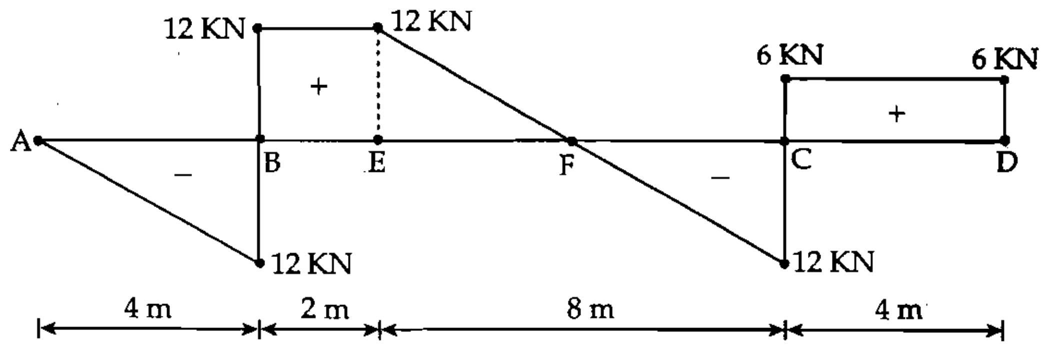


Figure 1

P.T.O.

(b) A circular steel bar ABCD, rigidly fixed at A and D is subjected to loads of 50 KN and 100 KN at B and C as shown in Figure 2, Find the loads shared by each part of the bar and displacements of the points B and C. Take E for steel as 200 GPa. **10**

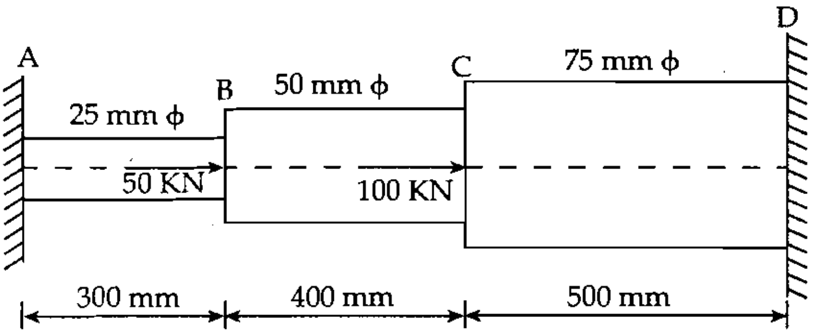


Figure 2

(c) Analyse the continous beam loaded as shown in Figure 3, by the slope deflection method. Support B sinks by 10 mm. Take $E = 2 \times 10^5$ N/mm^2, $I = 16 \times 10^7$ mm^4. Sketch the bending moment and shear force diagrams. **10**

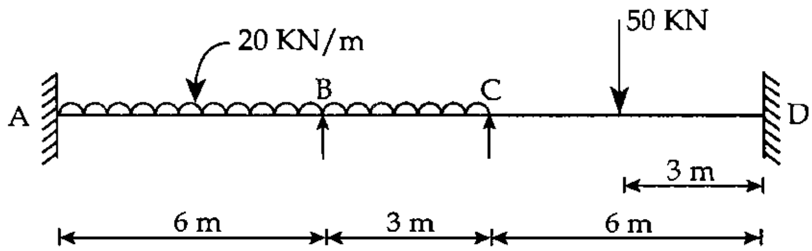


Figure 3

(d) Draw the shear force and bending moment diagrams for the continuous beam shown in Figure 4. Using theorem of three moments. **10**

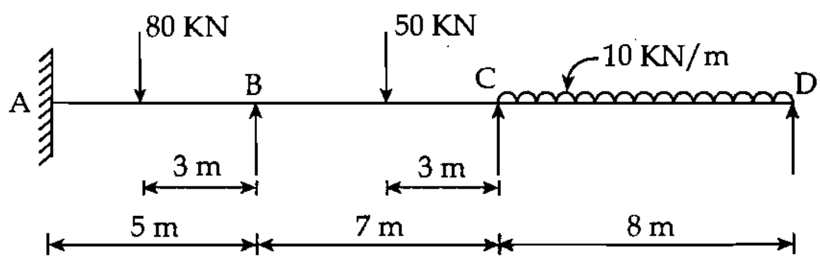


Figure 4

2. (a) The cross-section of cast iron beam is shown in Figure 5. The top flange is in compression and bottom flange is in tension. Permissible stress in tension is 30 N/mm^2 and it's value in compression is 90 N/mm^2. Determine how much concentrated load beam can carry at center of 5 m span. Given ends of beam are simply supported. **10**

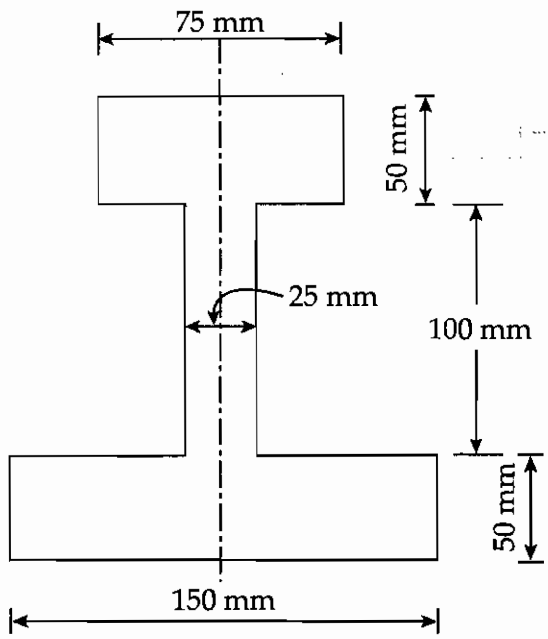


Figure 5

(b) A shaft composed of segments AC, CD and DB is fastened to rigid supports and loaded as shown in Figure 6, for bronze G = 35 GPa, Aluminium G = 28 GPa and for steel G = 83 GPa. Determine the maximum shearing stress developed in each segment. $T_C = 300$ N.M and $T_D = 700$ N.M. **10**

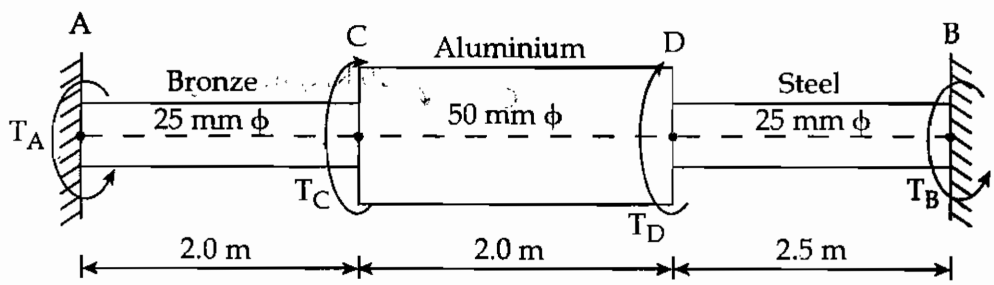


Figure 6

(c) Analyse the loaded frame shown in Figure 7, by moment distribution method and draw the bending moment diagram. **10**

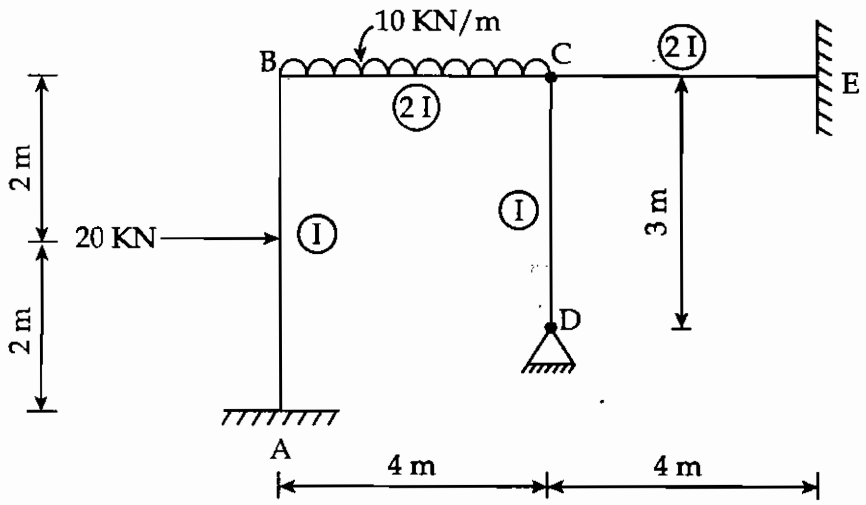


Figure 7

(d) Find the vertical deflection of point 'C' of the loaded truss shown in figure 8. The cross-sectional area of members CD and DE are each 2500 mm^2 and those of other members are each 1250 mm^2. Take $E = 200\ KN/mm^2$. **10**

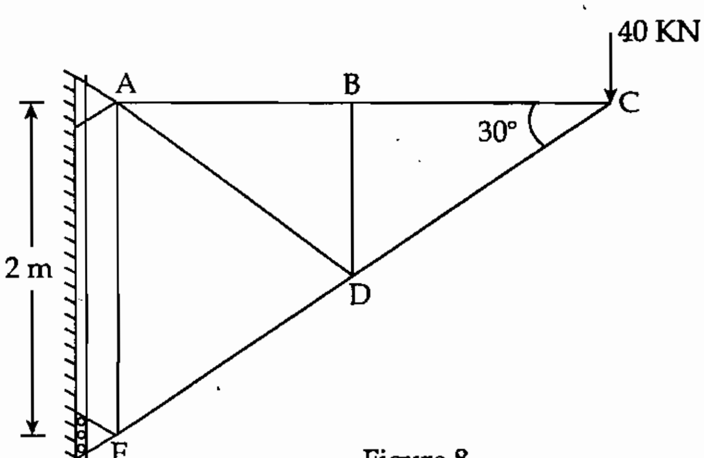
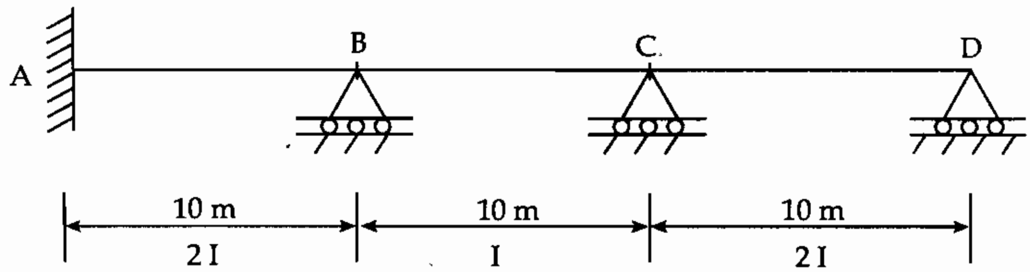


Figure 8

SECTION - B

3. (a) Calculate the flexural stiffness at point D of the three - span continuous beam ABCD shown in figure. **10**



(b) A suspension cable hangs between two points A and B separated horizontally by 90 m and with point B 15 m above A. The lowest point of the cable is 3 m below A. The cable supports a stiffening girder weighing 7.5 KN/m which is hinged vertically below A, B and the lowest point of the cable. Calculate the maximum tension which occurs in the cable when 200 KN wheel load crosses the girder from A to B. **10**

(c) An ISMB 500 @ 852.5 N/m transmits an end reaction of 300 KN and bending moment of 150 KN^{-m}, under factored loads, to the flange of a column ISHB 300 @ 576.8 N/m. Design a welded connection. **10**

(d) A column ISHB 350 @ 661.2 N/m carries an axial compressive factored load of 1700 KN. Design a suitable bolted gusset base. The base rests on M15 grade concrete pedestal. Use 24 mm diameter bolts of grade 4.6 for making the connections. **10**

4. (a) A bean ABC is supported at A, B and C and has an internal hinge at D at a distance of 4 m from A. AB = 8 m, and BC = 12 m. Draw the influence lines for : **10**

(i) Reaction at A R_a

(ii) Reaction at B R_b

(iii) Reaction at C R_c

(b) A parabolic arched rib, 30 m span, is hinged at the crown and springings and has a central rise of 5 m. A moving load of 15 KN/m longer than the span, rolls over the arch from left to right. Calculate the maximum positive and negative bending moment at the section 9 m from the left hand hinge. **10**

(c) Design a welded plate girder of 20 m span using the tension field action for the following factored forces : **10**

(i) Maximum moment - 5000 KN^{-m}.

(ii) Maximum shear force - 900 KN.

The girder is laterally restrained connections need not be designed.

(d) Design a column of effective length 5.90 m. It is subjected to a factored axial compressive load of 2000 KN. Provide two channels back to back connected with battens by site welded connection. Use steel of grade Fe 410. **10**

SECTION - C

5. (a) A singly Reinforced Concrete beam 230 mm wide and 400 mm effective depth. Using M20 and Fe 415 and using L.S.M. **10**
   (i) Calculate Mumax and Astmax for balanced design
   (ii) If depth of N.A. is limited to 0.35d. What will be values of Mu and Ast
   (iii) If the section is reinforced with 0.4% steel, determine the depth of N.A. and calculate Mu.

   (b) A R.C. beam section of size 230 mm wide $\times$ 500 mm deep has 4 Nos 20 mm bars in tension zone and 2 Nos 16 mm bars in compression zone. The effective span of beam is 5.5 m and clear cover to both reinforcement is 30 mm. Find safe working load the beam can carry by W.S.M. Use M20 and Fe415 take $\sigma_{abc} = 7$ N/mm^2 and $m = 13.33$. **10**

   (c) A Reinforced Concrete beam has a support section with a width of 300 mm and effective depth 600 mm. The support section is reinforced with 3 Nos of 20 mm dia. bars at an effective depth of 600 mm. 8 mm dia. 2 legged stirrups are provided at spacing of 200 mm as a shear Reinforcement near support. Estimate the shear strength of support section. Using M20 and Fe500 steel. Assuming $\tau_c = 0.48$ N/mm^2. Using L.S.M. **10**

   (d) Design a slab of size 3m $\times$ 7.8m using M20 and Fe 415 for flexture. Assuming M.F = 1.5 and $\tau_c = 0.36$ N/mm^2 K = 1.3, LL = 3.5 KN/m^2 and F.F = 1.0 KN/m^2. Take all necessary checks as per L.S.M. using $\tau_{bd} = 1.2$ N/mm^2. **10**

6. (a) Check the stability of Retaining wall to retain the earth 4m high. The top surface is horizontal behind the wall. The soil has unit weight of 17 KN/m^3 and Angle of internal friction $\phi = 30°$. The material under the wall base is same as above with S.B.C of soil = 150 KN/m^2 and $\mu = 0.55$ use M20 and Fe 415. **10**

   (b) Design a open React. water tank fixed at base on firm ground with capacity 1.5 lakh liters. Assuming depth of water in tank as 3.5m provide free board of 0.2m. Use M25 and Fe 415 steel. Use Approximate Method of design. Design long wall, short wall and base slab. **10**

   (c) Design one of the flight of stair of a school building spanning between landing beams to suit the following data : **10**
   (i) Type of stair case – Waist slab type
   (ii) No. of steps in a flight = 12
   (iii) Tread = 300 mm
   (iv) Riser = 160 mm
   (v) Width of landing beam = 400 mm
   (vi) Material – M20 and Fe 415

   (d) A Reinforced Concrete beam ABC of rectangular section is simply supported at A and C and continuous over support B. Span AB = 5m and BC = 4m. The beam carries a D.L. of 20 KN/m including self weight and L.L = 12 KN/m. Design the continuous beam by L.S.M. with 10% redistribution of moment. Use M20 and Fe 415. Draw B.M.D. envelops. **10**

SECTION - D

7. (a) Discuss the various properties of concrete in both fresh and hardened state, which affect the strength of concrete. **10**

(b) Explain : **10**

(i) Characteristic strength of concrete

(ii) Stress-strain behaviour of concrete. How the stress-strain behaviour is idealised to define the design strength of concrete ?

(c) Explain the three basic concepts of pre-stressing. Discuss why high-strength materials are required to be used in pre-stressed concrete. **10**

(d) A post-tensioned pre-stressed concrete beam of span 30 m is subjected to a pre-stressing force of 2500 KN at transfer. The profile of the cable is parabolic with zero eccentricity at supports and 200 mm at mid-span. The beam has a cross-section of 500 mm $\times$ 800 mm and is prestressed with 9 cables, one at a time, each cable consisting of 12 wires of 5 mm diameter. Determine the loss of prestress due to : **10**

(i) elastic shortening (ii) friction

Assume $Es = 2.1 \times 10^5$ N/mm^2, $Ec = 3.5 \times 10^4$ N/mm^2, Coefficient of friction = 0.3, Coefficient for length effect = 15×10^{-4} per metre.

8. (a) List at least four methods of mix design of concrete. Explain in detail the IS code method of mix design. **10**

(b) Explain the following with neat sketches : **10**

(i) Shuttering for a rectangular column

(ii) Shuttering for beam and slab floor

(c) Explain different types of post-tensioning systems with the help of neat sketches. **10**

(d) A pretensioned unsymmetrical I-section has a top flange of 300 mm $\times$ 150 mm and a bottom flange of 250 mm $\times$ 200 mm. The rib is 150 mm thick and 350 mm deep. The beam is prestressed by a straight cable with an eccentricity of 150 mm and carries a prestressing force of 400 KN. The beam is simply supported over a span of 10 m, and is subjected to a live load of 5 KN/m. Draw the stress distribution diagram at mid-span section for : **10**

(i) self weight and prestressing force

(ii) self weight, prestressing force and live load.

SECTION - E

9. (a) Using Newton-Raphson method, find root of the following non-linear equation with trial value of 5. **10**

$$x^2 - 5x + 4 = 0$$

(b) Evaluate $\int_1^7 \frac{1}{x}\,dx$ by Simpson's three - eighths rule and compare the value with the exact value of $\log_e 7$ of the integral. **10**

(c) Find the positive root of the equation $\cos x - 1.3x = 0$ correct to four decimal places using bi-section method. **10**

(d) Solve the following set of equations by using Gauss - Jordon method. **10**

$$0.732x_1 - 5.421x_2 + 1.013x_3 = 4.256$$
$$3.491x_1 + 2.203x_2 + 0.782x_3 = -7.113$$
$$0.961x_1 - 1.523x_2 + 4.265x_3 = 3.727.$$

10. (a) Solve the following quadratic equation by accelerated iteration method starting with any convenient initial value. **10**

$$x^2 + 2x - 2 = 0$$

(b) Write computer program for designing of laterally supported beam as per IS : 800. The program should be useful to handle the following load types : **10**

(i) Point load

(ii) Uniformly varying load

(iii) Uniformly distributed load

(iv) Combinations of above three

Use Fortran or C-language.

(c) Develop an algorithm and flowchart to design R.C.C. column subjected to axial load and uniaxial bending moment. **10**

(d) Write computer program in Fortran or C-language for designing flanged beam as per IS : 456. Data such as flange thickness, Web Width, overall depth and area of steel is to be given for particular B.M. and S.F. value. **10**

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