CSM – 18 / 15
Civil Engineering
Paper – I

Time : 3 hours

Full Marks : 300

The figures in the right-hand margin indicate marks.

*Candidates should attempt Q. No. 1 from Section – A and Q. No. 5 from Section – B which are compulsory and **three** of the remaining questions, selecting at least **one** from each Section.*

Section – A

1. Answer any **three** of the following :   20×3 = 60

   (a) Two point loads W_1 and W_2 $(W_2 > W_1)$ spaced at a distance 'd' travel from left to right across a simple supported girder, with W_1 leading. Prove that the limited span below which the greastest bending moment

anywhere in the girder will occur when the load W_1 has gone off the girder, is equale to $(1 + \sqrt{(W_2/(W_1 + W_2)})d$. Hence draw the maximum B. M. diagram if $W_1 = 4kN$; $W_2 = 6kN$; $d = 6m$ and the span $L = 10m$.

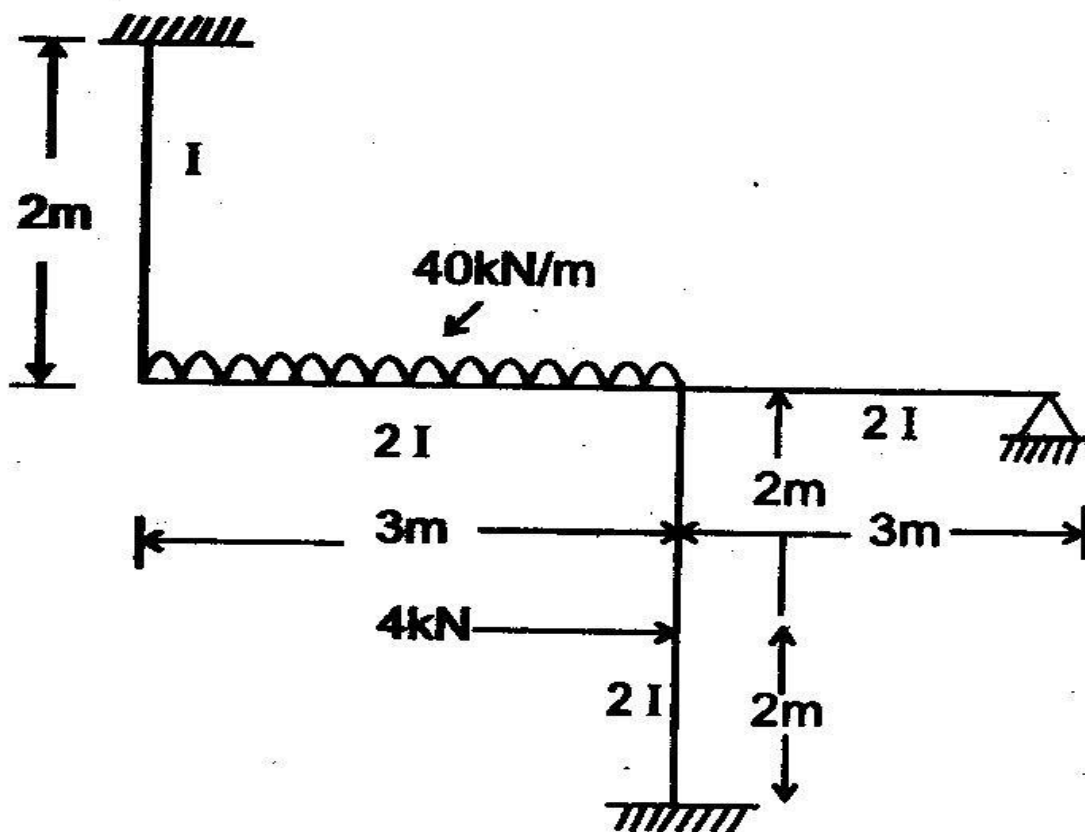(b) Draw the bending moment diagram and sketch the deflected shape of the frame shown in Fig 1.

Fig 1

(c) A symmetrical three hinged circular arch has a span of 16m and a rise to the central hinge of 4m. It carries a vertical load of 26 kN at 6m from left hand end. Find the maximum positive and negative bending moment.

(d) A suspension cable is supported at two points 20m apart. Left support is 2m above the right support the cable is loaded with UDL of 10 kN/m over whole span. The maximum dip in cable from left support is 4m. Find the maximum tension in cable.

2. (a) An R.C.C beam 300 mm wide and 700mm deep overall is reinforced with 3-20mm ϕ bars. The centres of the bars are 50 mm from the under side of the beam. The effective span of the beam is 6m. Use M20 concerete and Fe 415 steel.

(i) Find the safe UDL (superimposed) the beam can carry .

(ii) Find the central concentrated load that the beam can carry in addition to its self-weight. 20

(b) Calculate ultimate moment of resistance of a L-beam from the following data.

Width of flange = 1200mm

Depth of slab = 110mm

Effective depth = 600 mm

Width of web = 300 mm

Use concrete grade M20 and steel grade Fe 500.

Area of tension steel provided is :

(i) 4-25 mm ϕ bars

(ii) 6-25 mm ϕ bars

(iii) 8-25 mm ϕ bars 20

(c) A reinforced beam 300mm × 400mm effective is supported over a clear span of 6.5m. Width of support is 500mm. It carries

a factored UDL of 48 kN/m (including self-weight). The section is reinforced with 5-16mm φ bars. Using M20 concrete and Fe 450 steel, calculate shear reinforcement if :

(i) Only vertical stirrups are used

(ii) Two bars are bent-up at 45° at the same cross section. 20

3. (a) Design a slab simply supported on all sides for a room of size 4m × 5m (clear size) if the live load is 4 kN/m². The corners of the slab are not held down. Adopt M20 concrete and Fe 415 steel. 20

(b) A short R.C.C column is 400mm in diameter and is reinforced with 8 bars of 22mm diameter. Use M20 concrete and Fe 415 steel.

Find the ultimate load :

(i) If the column is wound with 10mm φ helical steel at 60mm pitch

(ii) If 6mm φ lateral ties @ 60mm c/c are used. 20

(c) A closed coil helical spring whose free lenght when not compressed is 150mm, is required to absorb strain energy equal to 50 N-m when fully compressed with the coils in contact. The maximum torsional shear strees is limited to 140 N/mm^2. Assuming a mean coil diameter of 100mm, find the diameter of steel wire required and the number of coils. Take $N=0.8 \times 10^5$ N/mm^2.

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4. [a] Find the collapse load for the frame of unifrom section shown in figure 2 under the applied factored loads.   20
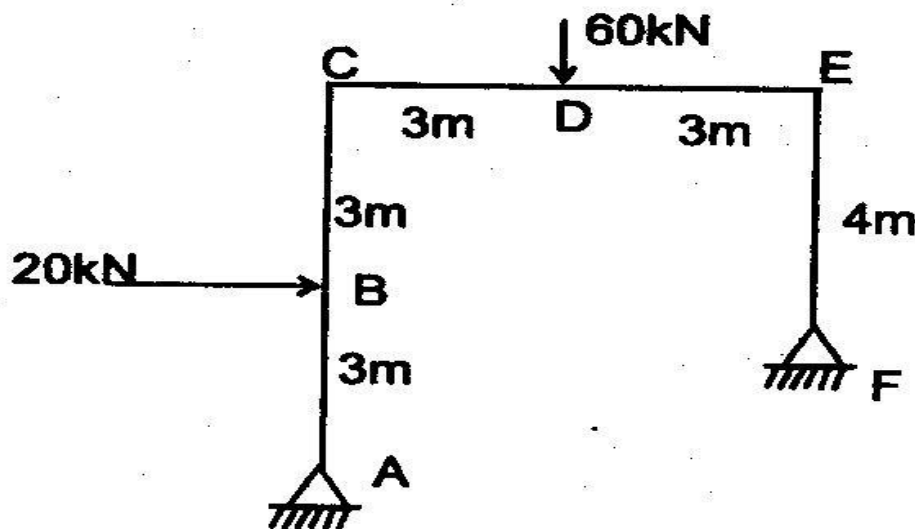

Fig 2

[b] Design a simply supported beam of span 6m, laterally unrestrained. The beam carries a working DL of 15 kN/m and LL of 10kN/m. Use F2 410 steel. The beam is laterally restrained by a cross beam framing at mid span. 20

[c] A cantilever AB , of length L is loaded with UDL throughout its length.

(i) Find the slope and deflection at any P, at a distance c from the free end.

(ii) If the end B is propped, find :

(a) Reaction at the prop

(b) Slopeat the propped end 20

Section – B

5. Attempt any **three** of the following : $20 \times 3 = 60$

(a) A fluid flow is given by $V = x^2 y i + y^2 z j - (2xyz + yz^2) k$. Prove that it is a case of possible steady incompressible flow.

Calculate the velocity and acceleration at the point (2, 1, 3)

(b) (i) Explain triaxial compression text : Apparatus and procedure.

(ii) A thin layer of slit exists at a depth of 18m below the surface of the ground. The soil above this level has an average dry density of 1.53 Mg/m^3 and an average water content of 36%. The water table is almost at the surface. Test on undisturbed samples of the soil indicates the following values :

$C_u = 45$ kN/m^2 : $\phi_u = 18°$; c' = 35 kN/m^2 ; $\phi = 27°$

(c) A cylindrical vessel 12cm in diameter and 30cm deep is filled with water up-to the top. The vessel is open at the top. Find the quantity of liquid left in the vessel, when it is rotated about its vertical axis with a speed of (a) 3000 r. p. m. and (b) 600 r. p. m.

(d) (i) The soil profile at a building site consists of dense sand up to 2m depth, normally loaded soft clay from 2 to 6m depth, and stiff impervious rock below 6m depth. The ground water table is at 0.40m depth below ground level. The sand has density of 18.5 kN/m^3 above water table and 19 kN/m^3 below it. For the clay, natural water content is 50%, liquid limit is 65% and grain specific gravity is 2.65. Calculate the ultimate probable settlement resulting from a uniformly distributed surface load of 40kN/m^2 applied over an extensive area of the site.

(ii) In a laboratory consolidation test with porous discs on either side of the soil sample, the 25mm thick sample took

81 minutes for 90% primary compression. Calculate the value of coefficient of consolidation for the sample.

6. (a) Crude oil of $\mu = 1.5$ poise and relative density 0.9 flows through a 20mm diameter vertical pipe. The pressure gauges fixed 20m apart read 58.86 N/cm^2 and 19.62 N/cm^2 as shown in Fig. 3. Find the direction and rate of flow of pipe. 20
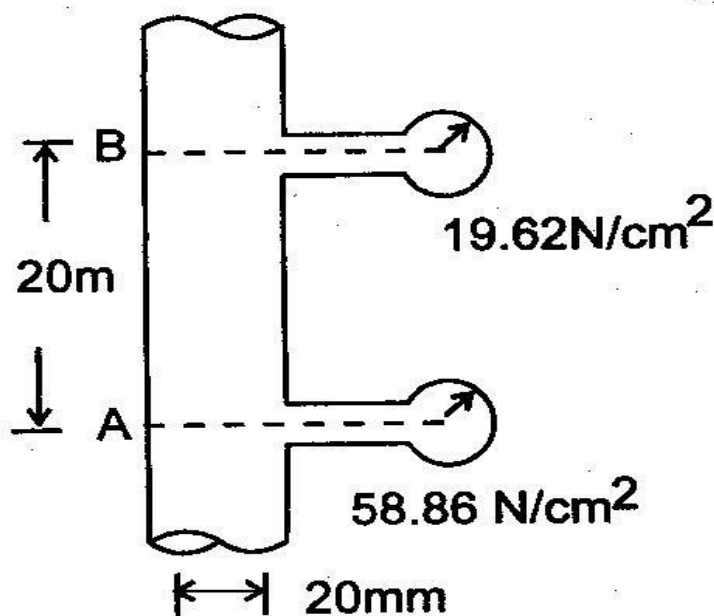

Fig 3

(b) A trapezoidal channel has side slopes 1 to 1. It is required to discharge 13.75m³/s of water with a bed gradient of 1 in 1000. If unlined, the value of Chezy's C is 44. If lined with concrete its value is 60. The cost per meter excavation is 4 times the cost per m² of lining. The channel is to be most efficient one. Find whether the lined or unlined canal will be cheaper. What will be the dimensions of that economical canal ? 20

(c) The plan of a proposed raft foundation 18m × 54m is shown in fig 4. The unifrom pressure from the foundation is 324 kN/m². Site investigations shows that the top 6m of subsoil is satrurated coarse sand with a unit wieght of 18.0 kN/m³. The ground water level occurs at 3.0m from the top of sand. The standard penetration value of the sand

taken at a depth of 4.5m is 18. Below the
sand there exists a clay layer of 30 m
thickness ($\dot{E}$=16.2 MN/m^2, $E_{swelling}$ = 63
MN/m^2). The clay rests on hard rock.
Determine the total settlement under the
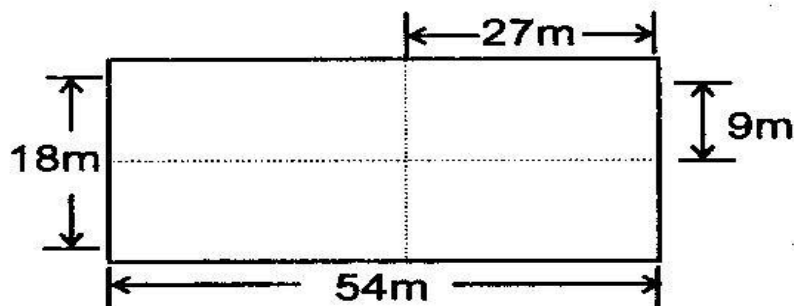foundation.   20

Fig 4

7. (a) A smooth pipe of diameter 80mm and 800 m
long carries water at the rate of 0.480 m^3/min.
Calculate the loss of head, wall shearing
stress, center line velocity, velocity and shear
stress at 30mm from pipe wall. Also
calculate the thickness of leminar's sub-
layer. Take kinematic viscosity of water as
0.015 stokes. Take the value of co-efficient

of friction 'f' from the relation given as

$$f = 0.0791/ (Re)^{0.25}$$

Where R_e = Reynold's number   20

(b) A pelton wheel develops 8000k W under a net head of 130m at a speed of 200 r. p. m.. Assuming the coefficient of velocity for the nozzle 0.98, hydraulic efficiency 87%, speed ratio 0.46 and jet diameter to wheel diameter ratio 1/9.

Determine

(i)   The discharge required

(ii) The diameter of wheel

(iii) The diameter and number of jets required

(iv) The specific speed

Mechanical efficiency is 75%   20

(c) A trapezoidal masonry retaining wall 1m wide at top and 3m wide at its bottom is 4m high. The vertical face is retaining soil

($\phi=30°$) at a surcharge angle of $20°$ with the horizontal. Determine the maximum and minimum intensities of pressure at the base of the retaining wall. Unit weights of masonry and soil are $24kN/m^3$ and $20kN/m^3$ respectively. Assuming the coefficient of friction at the base of the wall as 0.45, determine the factor of safety against sliding. Also determine the factor of safety against overturning.   20

8. (a) Prove that the manometric head of centrifugal pump running at speed N and giving a discharge Q may be written as

   $H_{mano} = AN^2 + BNQ + CQ^2$ (where A, B, C are constants)   20

   (b) Sketch the variation in total stress, effective stress and pore water pressure up-to a depth of 6m below ground level, given the

following data. The water table is 2m below ground level. The dry density of soil is 17.66 kN/m^3, water content is 12% ; specific gravity is 2.65. What would be the change in these stresses, if water table drops by 1.0m.

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(c) Explain effective stress analysis by Bishop's method. 20

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