CSM—20/23

PART—II/PAPER—VI

CIVIL ENGINEERING

PAPER—I

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Time : 3 Hours

Full Marks : 250

The question paper contains **18 (Eighteen)** *questions in* **GROUP—A (12)** *and* **GROUP—B (06)** *together.*

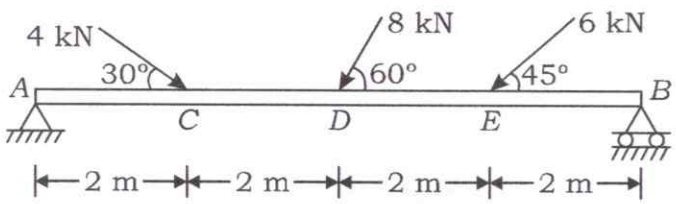
GROUP—A

Candidates to attempt **10** ***(ten)*** *questions within word limit of* **250**.

Each question carries **15** *marks.*

1. A block weighing 1500 N, overlying a 100 wedge on a horizontal floor and leaning against a vertical wall is to be raised by applying a horizontal force to the wedge. Assuming the coefficient of friction between all the surfaces in contact to be 0.3, determine the minimum horizontal force required to raise the block.

2. A horizontal beam *AB* of length 8 m is hinged at *A* and placed on rollers at *B*. The beam carries three inclined point loads as shown in the figure. Draw the S.F. and B.M. diagrams of the beam.



3. A truss of 8 m span consisting of seven members each of 4 m length is supported at its ends and loaded as shown in the figure. Determine the forces in members *BD*, *AB* and *DC* using method of joints.

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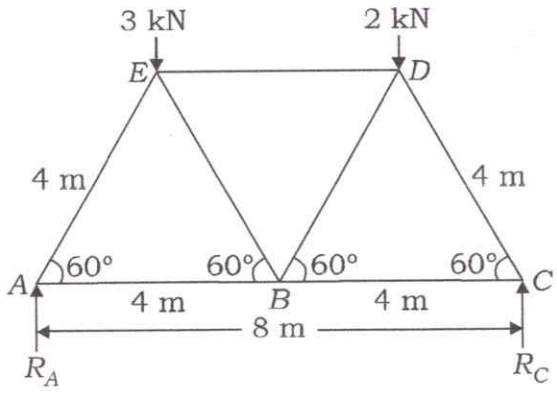
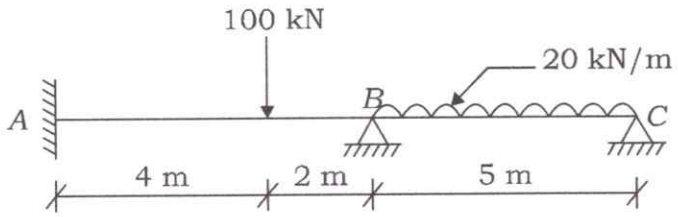
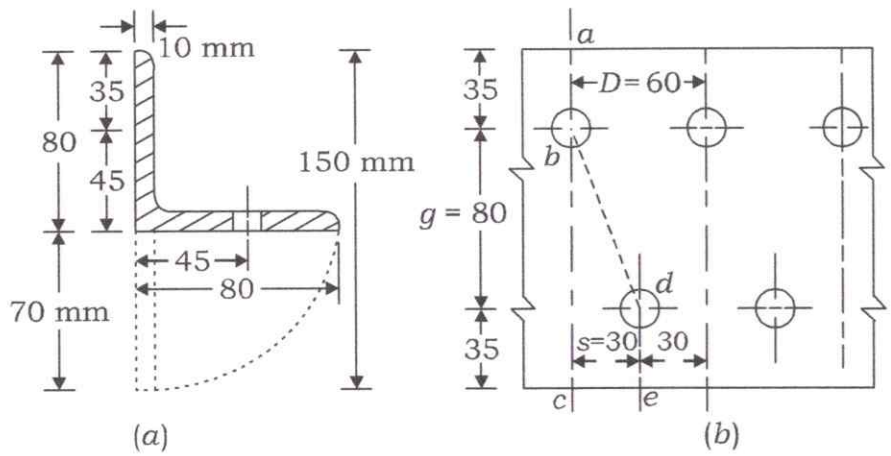


4. Analyze two span continuous beam *ABC* by slope deflection method. Draw the BM and SF diagrams. Take *EI* = constant.



5. An angle section ISA 8080 × 10 mm is used as a tension member and is connected to gusset plates by 16 mm dia. rivets through both legs. The pitch of rivets on each leg is 60 mm. However, the rivets on the two legs are staggered by 30 mm as shown in the figure. Taking permissible stress of 150 N/mm^2 in axial tension, determine the allowable axial tension.



6. Calculate the ultimate moment carrying capacity of a rectangular beam with b = 250 mm, d = 350 mm, A_{st} = 1800 mm^2. Assume grade 30 concrete and Fe 250 steel.

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TABLE B VALUES OF $\frac{x_{u,max}}{d}$ FOR DIFFERENT GRADES OF STEEL

(Clause 2.2)

f_y, N/mm^2	250	415	500
$\frac{x_{u,max}}{d}$	0.531	0.479	0.456

TABLE C LIMITING MOMENT OF RESISTANCE AND REINFORCEMENT INDEX FOR SINGLY REINFORCED RECTANGULAR SECTIONS

(Clause 2.3)

f_y, N/mm^2	250	415	500
$\frac{M_{u,lim}}{f_{ck}bd^2}$	0.149	0.138	0.133
$\frac{p_{t,lim}f_y}{f_{ck}}$	21.97	19.82	18.87

TABLE E MAXIMUM PERCENTAGE OF TENSILE REINFORCEMENT $p_{u,lim}$ FOR SINGLY REINFORCED RECTANGULAR SECTIONS

(Clause 2.3)

f_{ck}, N/mm^2	f_y, N/mm^2		
	250	415	500
15	1.32	0.72	0.57
20	1.76	0.96	0.76
25	2.20	1.19	0.94
30	2.64	1.43	1.13

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7. A prestressed concrete beam made of T-section has flange (1000 mm and 150 mm) and web 200 mm × 800 mm. Beam supports superimposed load of 180 kN/m over a simply supported span of 8 m. If the prestressing force in the tendon is 6200 kN at mid span and is located at a distance of 500 mm from soffit, determine the resultant stresses at mid-span for the following cases :

(i) Prestress + self-weight

(ii) Prestress + self-weight + superimposed load

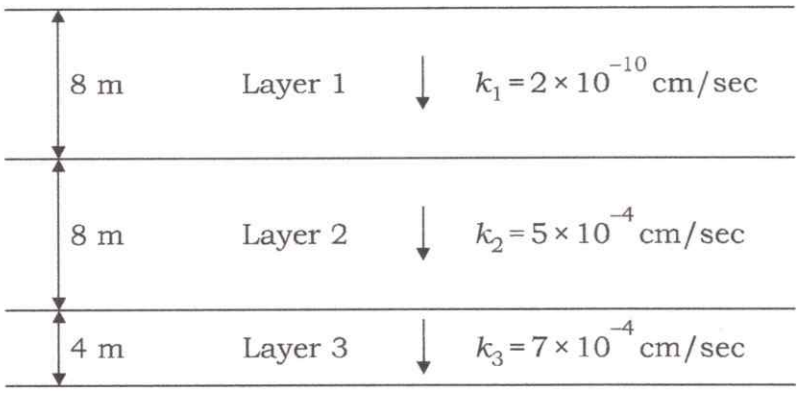
Take unit weight of concrete = 24 kN/m.

8. Derive the expression for Bernoulli's equation.

9. Oil of specific gravity 0.9 and kinematic viscosity 0.00033 $m^2\ s^{-1}$ is pumped over a distance of 1.5 km through a 75 mm diameter tube at a rate of 25×10^3 kg h^{-1}. Determine whether the flow is laminar and calculate the pumping power required, assuming 70 percent mechanical efficiency.

10. A centrifugal pump has the following characteristics : outer diameter of impeller = 800 mm; width of impeller vanes at outlet = 100 mm; angle of impeller vanes at outlet = 40°. The impeller runs at 550 r.p.m. and delivers 0.98 cubic meter of water per second under an effective head of 35 m. A 500-kW motor is used to drive the pump. Determine the manometric, mechanical and overall efficiencies of the pump. Assume water enters the impeller vanes radially at inlet.

11. In a falling head permeameter, the sample used is 20 cm long having a cross-sectional area of 24 cm^2. Calculate the time required for a drop of head from 25 to 12 cm if the cross-sectional area of the stand pipe is 2 cm^2. The sample of soil is made of three layers. The thickness and permeability of each layer is as shown in the figure. Assume that the flow is taking place perpendicular to the layers.



12. A rectangular footing of size 3 m × 2 m is founded at a depth of 1.5 m in a clay stratum of very stiff consistency. A clay layer of medium consistency is located at a depth of 1.5 m below the bottom of the footing, as shown in the figure.

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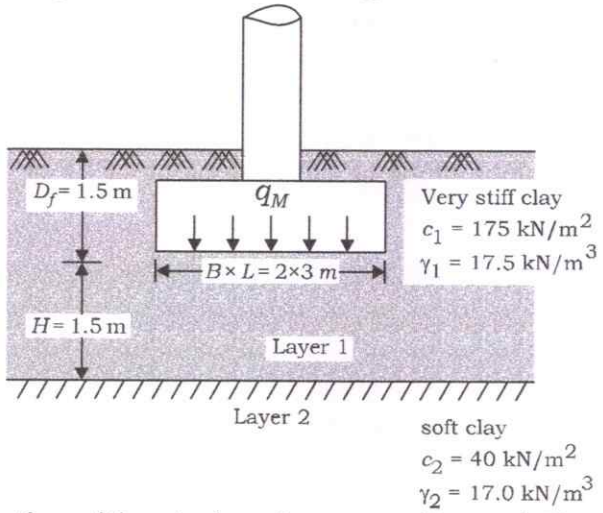


Estimate the ultimate bearing capacity and the allowable bearing pressure on the footing with a factor of safety of 3.

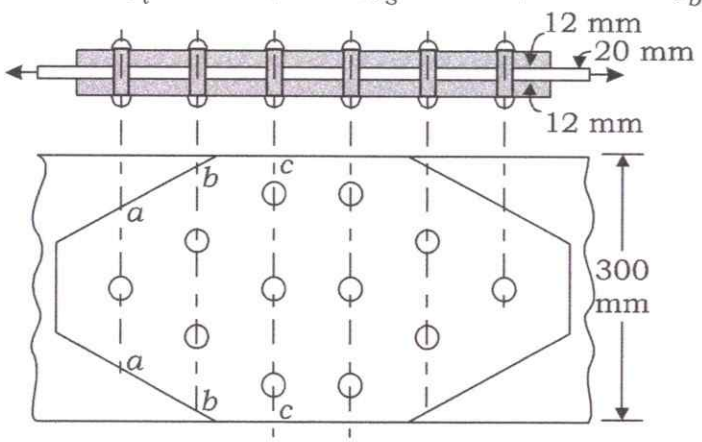
GROUP—B

Candidates to attempt **05** ***(five)*** *questions within word limit of* **300**.

Each question carries **20** *marks.*

13. A horizontal beam 10 m long is carrying a uniformly distributed load of 1 kN/m. The beam is supported 6 m apart. Find the position of the supports, so that B.M. on the beam is as small as possible. Also draw the S.F. and B.M. diagrams.

14. A butt joint is used to connect two 20 mm thick plates as shown in the figure. The diameter of rivets is 18 mm. Determine the efficiency of the joint. Take f_t = 470 N/mm^2, f_s = 375 N/mm^2 and f_b = 780 N/mm^2.



15. A concrete beam having a rectangular section 150 mm × 300 mm is prestressed by a parabolic cable at an eccentricity of 75 mm at mid-span towards bottom soffit and at an eccentricity of 25 mm towards top at support sections. The effective prestressing force is 350 kN. The beam supports a concentrated live load of 20 kN at the centre of span in addition to the self-weight with a span 8 m. Find the short-term deflection at the centre of span under prestress, self-weight and live load. Find also the long-term deflection if the loss ratio is 0.8 and the creep coefficient is 1.6. Take E_c = 38 kN/mm^2.

16. A trapezoidal channel with side slopes of 2 horizontal to 1 vertical has to carry a discharge of 20 m^3/s. If the bottom width is 4 m, calculate the bottom slope required to maintain a uniform flow at a depth of 1.5 m. Take Manning's n = 0.015. What would be the normal depth of flow for the above channel to carry a discharge of 27 m^3/s?

17. 500 g sample of dry soil was used for a combined sieve and hydrometer analysis (152 H type hydrometer). The soil mass passing through the 75-micron sieve = 120 g. Hydrometer analysis was carried out on a mass of 40 g that passed through the 75-micron sieve. The average temperature recorded during the test was 30 °C. Given : G_s = 2.55, C_m (meniscus) = 0.50, C_o = +2.5, viscosity = 8.15×10^{-3} poises. The actual hydrometer reading R_a = 15.00 after a lapse of 120 min after the start of the test. Determine the particle size D and percent finer P'% and P%.

18. A laboratory sample of clay 2 cm thick took 15 min to attain 60 percent consolidation under a double drainage condition. What time will be required to attain the same degree of consolidation for a clay layer 3 m thick under the foundation of a building for a similar loading and drainage condition?

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