

4. (a) A direct shear box test performed on a remoulded sand sample yielded the following observations at the time of failure:

Normal load = 0.36 kN

Shear load = 0.16 kN

The sample area was 36 cm^2 .

Determine :

- the angle of internal friction,
- the magnitude and direction of the principal stresses in the zone of failure, and
- the magnitude of maximum deviator stress if a sample of the same sand with the same void ratio were tested in a triaxial test with an all-round pressure of 60 kN/m^2 . Assume $c = 0$.

18

- (b) A 2.2 m square footing is located at a depth of 4.4 m in a stiff clay of saturated unit weight 21 kN/m^3 . The undrained strength of clay at a depth of 4.4 m is given by parameter $w = 120 \text{ kN/m}^2$ and $\phi_u = 0$. For a factor of safety 3, with respect to shear failure, compute (i) the net value of bearing capacity, and (ii) the value of maximum load that could be carried by the footing.

12

5. (a) The space between two square flat parallel plates is filled with oil. Each side of the plate is 60 cm . The thickness of the oil film is 12.5 mm . The upper plate, which moves at 2.5 m per sec requires a force of 98.1 N to maintain the speed. Determine :

- the dynamic viscosity of the oil in poise, and
- the kinematic viscosity of the oil, in stokes, if the specific gravity of the oil is 0.95.

15

- (b) A pelton wheel is to be designed for the following specifications

Shaft power = $11,772 \text{ kW}$; Head = 360 m ;

Speed = 750 r.p.m. ; Overall efficiency = 86% ;

Diameter is not to exceed one-sixth of the wheel diameter.

Determine :

- the wheel diameter
- the number of jets required, and
- diameter of the jet

Take coefficient of velocity = 0.985 and speed ratio = 0.45 .

15

6. (a) Write short notes on the following

- Sewer
- Sewage
- Sewerage system
- Drain and trench drain

- (b) Design a (15×10^6) p.d. water treatment plant with rapid gravity sand filter. Assume suitable design parameters.

18

SECTION II
(Structural)

7. (a) When a bar of certain material 40 cm square is subjected to an axial pull of 1,00,000 N the extension on a gauge length of 200 mm is 0.1 mm and the decrease in each side of the square is 0.005 mm. Calculate Young's modulus, Poisson's ratio, shear modulus and bulk modulus for this material. 10
- (b) Draw S.F. and B.M. diagrams for the beam having overhangs on both sides and loaded as shown in Fig. 1. 20

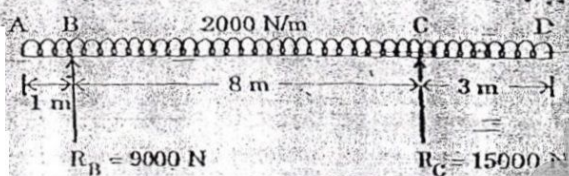


Fig. 1

8. (a) Find the deflections at points D and C of the beam loaded as shown in Fig. 2. 15

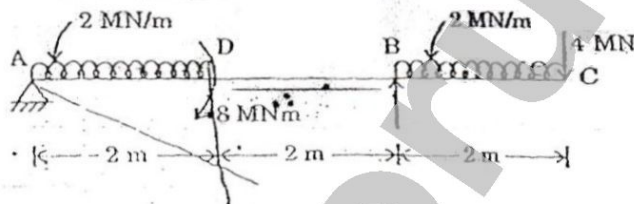


Fig. 2

- (b) A solid steel column and a hollow steel column, both have the same length and same cross-section area, and are fixed at the ends. If the internal diameter of hollow column is $\frac{2}{3}$ of its external diameter, find the ratio of buckling strengths of solid steel column to that of hollow steel column. 15
9. (a) Explain the important properties of cement concrete both in plastic and hardened stage. 15
- (b) Describe the sequence of concreting operations. 15
10. (a) A particular sand sample of 250 grams, when sieved successively through the following sieves, left retentions on the sieves as follows:
- | | | | | | | | |
|-----------------|-------|-----|-----|-----|----|----|----|
| IS sieve | 10 mm | 480 | 240 | 120 | 60 | 30 | 15 |
| Retention grams | NIL | 10 | 15 | 50 | 50 | 75 | 50 |
- What is its fineness modulus? What sand is it - fine, medium or coarse? 10
- (b) Design a simply supported R.C.C. slab for an office floor having clear dimensions of 4 m by 10 m with 230 mm walls all-around. Adopt M-20 grade concrete and Fe-415 grade HYSD bars. 20

11. Design a cantilever retaining wall to retain an earth embankment 4 m high above ground level. The density of earth is 18 kN/m^3 and its angle of repose is 30° . The embankment is horizontal at top. The safe bearing capacity of the soil may be taken as 200 kN/m^2 and the coefficient of friction between soil and concrete is 0.5. Adopt M-20 grade concrete and Fe-415 HYSD bars. 30
12. (a) Find the suitable pitch for single riveted lap joint for plates 1 cm thick, if $\sigma_t = 150 \text{ N/mm}^2$, $\sigma_s = 100 \text{ N/mm}^2$ and $\sigma_b = 300 \text{ N/mm}^2$. 12
- (b) Calculate the maximum load that the bracket shown in Fig. 3 can carry if the size of the weld on flange is 8 mm and that on the web is 5 mm. The allowable shear stress is 102.5 N/mm^2 . 18

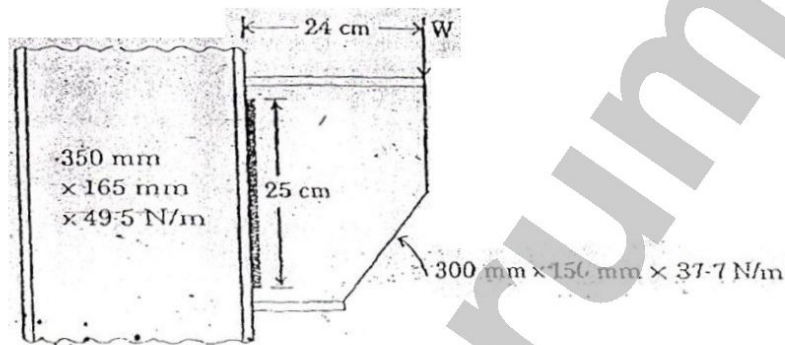


Fig. 3